NORTHERN WATER QUALITY MONITORING

Proceedings of the Technology Transfer Workshop

SURVEILLANCE DE LA QUALITÉ DES EAUX DU NORD

Comptes rendus de l'atelier sur l'échange d'informations d'ordre technologique

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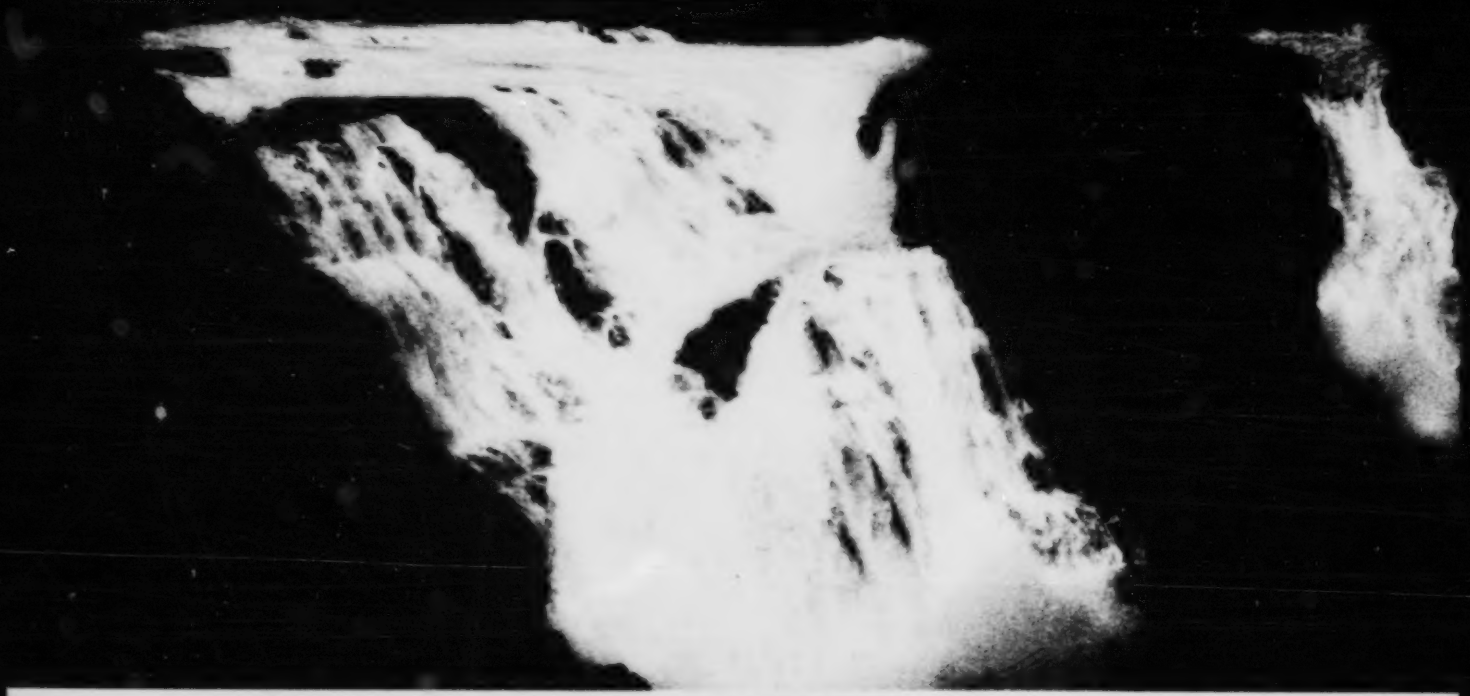

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ETUDE N° 7, SÉRIE DES ATELIERS TECHNIQUES

INLAND WATERS DIRECTORATE
OTTAWA, CANADA, 1988

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OTTAWA, CANADA, 1988

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Coordinating/Editorial Committee, Northern Water Quality Monitoring Workshop. *Left to right*: Brian Olding (Western and Northern Region), Roy Kwiatkowski (Headquarters, Chairperson), Hague Vaughan (Western and Northern Region), Paul Whitfield (Pacific and Yukon Region).

Cover photograph –

Virginia Falls, South Nahanni River, Northwest Territories (*Courtesy of Parks Canada*)

PROCEEDINGS

of the

TECHNOLOGY TRANSFER WORKSHOP

NORTHERN WATER QUALITY MONITORING

Yellowknife, Northwest Territories, May 4-7, 1987

TECHNICAL WORKSHOP SERIES NO. 7

COMPTES RENDUS

de

L'ATELIER SUR L'ECHANGE D'INFORMATIONS D'ORDRE TECHNOLOGIQUE

SURVEILLANCE DE LA QUALITE DES EAUX DU NORD

Yellowknife (Territoires du Nord-Ouest), 4 au 7 mai 1987

ETUDE N° 7, SERIE DES ATELIERS TECHNIQUES

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INTRODUCTION

Water represents one of Canada's most valuable resources, covering 7.6% of its surface. There is no substitute for water. The survival of all forms of life depends upon an adequate supply of water of acceptable quality. Thus, sound knowledge of water quality is essential to all levels of government for the management of Canada's present water uses and for the planning of future uses. While management responsibilities for water are shared between the provinces and the federal government, the federal government plays an important leadership role, particularly when addressing water quality on a national level. The Water Quality Branch, Inland Waters Directorate, Department of the Environment, is responsible for providing this leadership. The purpose of the Water Quality Branch is to provide scientific and technical information and advice on ambient water quality to promote the conservation and enhancement of the quality of Canada's inland water resources for the economic and social benefit of all Canadians.

Although the North is blessed with what appears to be an abundance of water of good quality, the North and all northerners are vulnerable to the environmental issues that plague the southern provinces. The following water issues are of concern to the North:

(1) long range transport (atmospheric) of toxic substances has been detected in the remote arctic areas;
(2) a large portion of the North's water comes from other jurisdictions (provinces to the south, Alaska);
(3) water quality problems, although relatively few, have already emerged in the North;
(4) the North will be particularly vulnerable to predicted future climatic changes.

The Water Quality Branch of Environment Canada is the lead agency responsible for the collection and dissemination of data on ambient surface water across Canada. The Branch is presently negotiating federal-provincial monitoring agreements to establish a comprehensive national water quality network to improve interjurisdictional assessments and address nationwide water quality concerns. In the near future, the Inland Waters Directorate and Indian and Northern Affairs Canada (INAC) will make a joint request to Treasury Board for new resources to implement federal-territorial agreements, thus forming a truly national water quality network.

It was concluded that within the Inland Waters Directorate, simple application of water quality monitoring strategies designed for temperate (southern) areas would fail to yield cost-effective information for the North. While logistical costs are a primary consideration in the implementation of a Northern Monitoring Strategy, prevailing issues and hydrological extremes compound the complexity of any strategy. Furthermore, the need to ensure that northern resource developments continue to be compatible with the protection of aquatic life within this fragile ecosystem presents special problems.

To generate the information which would result in the efficient design of water quality monitoring activities in the North, leading experts in northern aquatic ecology were invited to present state of the art techniques in their respective fields relevant to the Workshop. A secondary objective of the Workshop was the establishment of information flow/coordination between the various water quality monitoring and research agencies working in the North. The territorial governments (Yukon Territorial Government, Government of the Northwest Territories), other federal related agencies (Canada Wildlife Service, Environmental Protection Service, Health and Welfare Canada, Fisheries and Oceans), regulatory bodies (Yukon Water Board, Northwest Territories Water Board), universities and native groups were invited to participate.

Day 1 of the workshop was devoted to presentations from the various water quality data users and data collectors. Days 2, 3 and 4 were devoted to solicited presentations and work group sessions on three issues: General Monitoring in the North, Mining, and Hydrocarbons. Work group participants were asked to focus on three aspects of water quality monitoring: optimization of monitoring effort, multi-media (water, sediment and biota) sampling, and the assessment and management of the water resource. Plenary sessions were held at the end of each day so that work groups could report their findings to the Workshop.

These proceedings are verbatim transcripts of day 1 and the Plenary sessions of days 2, 3 and 4. Solicited presentations for the subjects General Monitoring, Mining and Hydrocarbons will appear in a special issue of the Water Pollution Research Journal of Canada. The dual proceedings approach used is an attempt to provide information to both the water quality managers and the scientific community within their own forum. It was hoped that this would generate links between the various groups monitoring the North and promote cooperative efforts to the development of a Northern Monitoring Strategy from which all participants could work.

Note to Reader: These proceedings, with minor editing, are a verbatim transcript of the presentations made during the Workshop. Some of the figures and slides referred to during the Workshop have not been included.

INTRODUCTION

L'eau constitue l'une des ressources les plus précieuses du Canada couvrant 7,6 % de son territoire. Rien ne remplace l'eau. La survie de toutes les formes de vie dépend d'un approvisionnement adéquat en eau de qualité acceptable. Par conséquent, il est essentiel que tous les ordres de gouvernement connaissent parfaitement le domaine de la qualité de l'eau pour gérer les utilisations actuelles qu'on en fait au Canada et planifier celles de l'avenir. Les provinces et le gouvernement fédéral se partagent les responsabilités en matière de gestion des eaux; toutefois, le gouvernement fédéral joue un rôle important de direction, notamment lorsqu'il s'occupe de la qualité des eaux à l'échelle nationale. La Direction de la qualité des eaux, Direction générale des eaux intérieures, ministère de l'Environnement est l'organisme chargé de prendre l'initiative dans ce domaine. Cette direction a pour but de fournir des renseignements et des conseils scientifiques et techniques au sujet de la qualité de l'eau afin de promouvoir la conservation et l'amélioration de la qualité des ressources en eaux intérieures de sorte que tous les Canadiens puissent en tirer des avantages économiques et sociaux.

Même si le Nord semble doté de réserves d'eau abondantes et de bonne qualité, la région et tous ceux qui y vivent sont vulnérables aux problèmes environnementaux qui affligent les provinces du sud. Parmi les questions relatives à la qualité des eaux qui préoccupent le Nord, on retrouve : l'existence du transport à distance de substances toxiques (dans l'air) dans des régions éloignées de l'Arctique; la provenance d'une grande partie des eaux du Nord du territoire régi par d'autres pouvoirs publics (provinces du sud; Alaska); l'existence, bien qu'en petit nombre, de problèmes concernant la qualité de l'eau dans le Nord; la sensibilité prévisible du Nord aux changements climatiques prévus.

La Direction de la qualité des eaux d'Environnement Canada est le principal organisme responsable de la collecte et de la diffusion de données sur les eaux de surface dans l'ensemble du Canada. La Direction négocie présentement des accords fédéraux-provinciaux concernant la surveillance continue afin de bien mettre sur pied un réseau national complet de stations d'échantillonnage de la qualité des eaux, ce qui permettra d'améliorer les évaluations de la qualité des eaux relevant de plusieurs pouvoirs publics et de s'attaquer aux problèmes de qualité de l'eau qui sévissent à la grandeur du pays. La Direction générale des eaux intérieures et Affaires indiennes et du Nord Canada présenteront bientôt une requête au Conseil du Trésor afin d'obtenir de nouvelles ressources pour l'exécution d'accords fédéraux-territoriaux, créant ainsi un véritable réseau national d'échantillonnage de la qualité des eaux.

Il a été conclu que l'application, à l'intérieur de la Direction générale des eaux intérieures, de stratégies visant la surveillance continue de la qualité des eaux adaptées aux régions tempérées (du sud) ne serait pas rentable en vue de la production de données pour le Nord. Bien que les coûts de logistique représentent une considération première dans la mise en oeuvre d'une stratégie de surveillance continue dans le Nord,

les problèmes actuels et les conditions hydrologiques extrêmes rendent encore plus difficile l'établissement d'une stratégie. En outre, des problèmes particuliers proviennent du fait qu'il faille s'assurer que les projets de mise en valeur des ressources du Nord continuent d'être compatibles avec la protection de la vie aquatique issue de ce fragile écosystème.

Afin de produire des données qui permettraient de bien concevoir les activités de surveillance continue de la qualité des eaux dans le Nord, les principaux experts de l'écologie aquatique du Nord ont été invités à présenter les toutes dernières techniques dans leur domaine respectif se rapportant à l'atelier. Ce dernier avait comme second objectif de permettre la création d'un système d'échange et de coordination des données entre les divers organismes oeuvrant dans la recherche et dans la surveillance continue de la qualité des eaux dans le Nord. Les gouvernements territoriaux (Yukon et Territoires du Nord-Ouest), d'autres organismes fédéraux connexes (Service canadien de la faune, Protection, Santé et Bien-être social Canada, Pêches et Océans), des organismes de réglementation (commissions des eaux du Yukon et des Territoires du Nord-Ouest), des universités et des groupes d'autochtones ont été invités à participer à l'événement.

La première journée de l'atelier a été consacrée à des exposés de divers utilisateurs de données sur la qualité des eaux et de personnes responsables de leur collecte. Les deuxième, troisième et quatrième jours ont été consacrés aux exposés des conférenciers invités et à des séances de travail en groupes sur trois sujets : aperçu de la surveillance continue dans le Nord; l'exploitation minière; les hydrocarbures. Les participants aux séances de groupe ont été appelés à se pencher sur trois aspects de la surveillance continue de la qualité des eaux : optimisation des efforts dans ce domaine; échantillonnage de véhicules multiples (eau, sédiments et biotes); évaluation et gestion des ressources en eau. Des séances plénières ont eu lieu tous les jours afin de permettre aux groupes de faire part de leurs résultats aux autres participants de l'atelier.

Dans le but de renseigner tant les gestionnaires de la qualité des eaux que les scientifiques au sein de leur propre tribune, on a adopté un double mode de présentation et de diffusion pour la publication du compte rendu. On espérait ainsi établir des liens entre les différents groupes travaillant à la surveillance continue du Nord et encourager les efforts de collaboration en vue de l'élaboration d'une seule stratégie de surveillance continue dans le Nord que tous les participants pourraient adopter.

Remarque à l'intention du lecteur: Ce compte rendu rassemble les textes des exposés présentés lors des ateliers. Ces textes n'ont subi qu'une légère révision. Certaines figures et diapositives présentées lors des ateliers ne sont pas reproduites dans ce compte rendu.

ACKNOWLEDGMENTS

The Coordinating Committee would like to thank the Director, Water Quality Branch, Headquarters, and the Chief, Water Quality Branch, Western and Northern Region, for their financial assistance to the Workshop. Special thanks go to Mr. Glenn Warner, Chairperson of the Northwest Territories Water Board, who arranged for the verbatim transcripts. Thanks are also given to Mr. Tom Dafoe and Mr. Art Redshaw for their assistance as honorary Workshop Committee members. The financial assistance received from the Research Coordination and Program Evaluation Branch of the Inland Waters Directorate is greatly appreciated.

AGENDA
Northern Water Quality Monitoring Workshop

Yellowknife, Northwest Territories

May 4-7, 1987

Coordinating Committee:

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May 3, Sunday

19:20 - 21:00	Pre-registration, Katimavik Lobby, Explorer Hotel	

May 4, Monday

	Registration, Katimavik Lobby, Explorer Hotel	
	INTRODUCTION	
	Katimavik Room B, Explorer Hotel	
08:50 - 08:55	Welcome	A. Redshaw
08:55 - 09:05	Workshop Instructions Announcements	R. Kwiatkowski
Session 1	**WATER QUALITY INFORMATION NEEDS** Katimavik Room B Session Chairperson: T. Dafoe	
09:05 - 09:15	Chairperson's Address	
09:15 - 09:35	NWT Department of Renewable Resources	R. Livingston
09:35 - 09:55	NWT Chamber of Mines	D. Nutter
09.55 - 10.15	Rawson Academy of Aquatic Sciences	D. Gamble
10:15 - 10:45	Coffee	
10:45 - 11:05	Dene Nation	J. Bekale
11:05 - 11:25	Northwest Territories Water Board	G. Warner
11:25 - 11:55	General Discussion	
11:55 - 13:30	Lunch	

Session 2	**WATER QUALITY MONITORING ACTIVITIES IN THE NORTH** Katimavik Room B Session Chairperson: P. Whitfield	
13:30 - 13:40	Chairperson's Address	
13:40 - 14:00	Inland Waters Directorate, Environment	B. Olding
14:00 - 14:20	Indian and Northern Affairs Canada/NWT	D. Stendahl
14:20 - 14:40	Indian and Northern Affairs Canada/Yukon	G. Whitley
14:40 - 15:00	Environmental Protection, Environment Canada	D. Sutherland
15:00 - 15:30	Coffee	
15:30 - 15:50	National Hydrology Research Institute, Environment Canada	L. Johnston D. Craig
15:50 - 16:00	National Water Research Institute, Environment Canada	R. Allan
16:00 - 16:20	Water Quality Objectives and Their Use in Water Management	K. Thompson
16:20 - 16:50	General Discussion	
16:50 - 17:00	Workshop Update	R. Kwiatkowski
17:30	Wine and cheese get-together Katimavik Room A	

May 5, Tuesday

Session 3	**GENERAL** Katimavik Room B Session Chairperson: H. Vaughan	
08:00 - 08:10	Chairperson's Address	
08:10 - 08:35	Arctic Limnology and Terrain Geochemical Surveys, District of Keewatin	T. Edwards R. Klassen W. Shilts
08:35 - 09:00	Preliminary Study of Water Quality in 15 Major Water Courses of Northern Quebec	C. Langlois L. Poissant
09:00 - 09:25	Impacts on River Discharge of Changes in Glacierized Components of Mountain Basins	P. Johnson C. David
09:25 - 09:55	Coffee	
09:55 - 10:20	Ground-Water Issues in Northern Canada	D. McNaughton
10:20 - 10:45	Considerations in the Development of Monitoring Strategies to Determine Compliance with Objectives	D. Valiela P. Whitfield N. Rousseau
10:45 - 12:45	Work Group Sessions	
12:45 - 14:15	Lunch	
14:15 - 14:45	Chairperson and Recorders Finalize Work Group Sessions	
14:45 - 15:15	Chairpersons present Work Group results to Work Groups for comment	
15:15 - 16:15	Work Group Chairpersons' presentations to workshop (15-minute presentations)	
16:15	Tour of Yellowknife (Arrangements to be announced)	

May 6, Wednesday

Session 4	**MINING** Katimavik Room B Session Chairperson: D. Nutter	
09:00 - 09:10	Chairperson's Address	
09:10 - 09:35	A Framework to Improve the Effectiveness of Aquatic Environment Impact Assessment	W. Duncan E. Neil
09:35 - 10:00	Progress Towards Standardized Programs to Monitor the Effects of Mining Developments on Lakes in the Northwest Territories	G. Packman M. Gordon
10:00 - 10:25	Treatment of, and Gold Recovery from, Effluent at Giant Yellowknife Mines Ltd.	G. Halverson T. Raponi
10:25 - 10:55	Coffee	
10:55 - 11:20	The Influence of Coal Mine Activities on the Quality of Stream-Bed Substrates in Fording River, B.C.	D. MacDonald L. McDonald
11:20 - 11:45	Radionuclide Monitoring of Surface Waters in the North	A. Baweja D. Sutherland B. Olding
11:45 - 12:10	The Impact of Effluents from a Uranium Mine and Mill Complex in Northern Saskatchewan on Contaminant Concentrations in Receiving Waters and Sediments	T. Hynes R. Schmidt T. Meadley N. Thompson
12:10 - 13:30	Lunch	
13:30 - 15:50	Work Group Sessions	
15:30 - 16:00	Chairpersons and Recorders finalize Work Group Sessions	
16:00 - 16:30	Chairpersons present Work Group results to Work Group for comment	
16:30 - 17:30	Work Group Chairpersons' presentations to Workshop (15-minute presentations)	
19:00 - 19:45	Cash Bar Katimavik Room B, Explorer Hotel	
19:45 -	BANQUET Katimavik Room B, Explorer Hotel Guest Speaker: Bob MacQuarrie NWT Yellowknife Centre MLA	

May 7, Thursday

Session 5	**HYDROCARBONS** Katimavik Room B Chairperson: B. Olding	
09:00 - 09:10	Chairperson's Address	

09:10 - 09:35	Determination of Hydrocarbon Exposure Effects on Freshwater Northern Fishes Using Bile Analysis	J. Morgan G. Vigers P. Nix J. Park
09:35 - 10:00	Contaminant Studies with Fish from the Lower Mackenzie Drainage	L. Lockhart D. Metner D. Muir
10:00 - 10:30	Coffee	
10:30 - 12:30	Work Group Sessions	
12:30 - 14:00	Lunch	
14:00 - 14:30	Chairpersons and Recorders finalize Work Group Sessions	
14:30 - 15:00	Chairpersons present Work Group results to Work Group for comment	
15:00 - 16:00	Work Group Chairpersons' presentations to Workshop (15-minute presentations)	
16:00	General Discussion	
17:00	Workshop Ends	

May 9, Friday

09:00 - 12:00	An underground tour of a local mine may be arranged for those who wish to spend an extra day in Yellowknife. Please sign sheet at registration desk if interested.

Session 1
Water Quality Information Needs

Session Chairperson: Mr. Tom Dafoe

T. Dafoe: The Water Quality Branch is just one of the many organizations involved in water quality, and water quality in the North. Our role is limited, but nonetheless what we do, we feel should be done well, and one of the reasons we're here is to find out what information and data are required; how we should go get it; and to get this advice and input from the users of the data. This morning we're going to have a cross section of some of these users in terms of legislators, some of the people from the Territories, industry, the academics, and from all of this advice, through the presentations and through the workshop sessions, we're hoping that we can do a better job of what we're going to do. We need insights from the people using the science, and we want to make use of the experience and expertise of people and how to gather this information. Basically, we're here to listen.

Our first speaker will be Ron Livingston, who is Director of Policy and Planning of Renewable Resources with the Government of the Northwest Territories [GNWT]. Ron came from Manitoba about seven years ago, and while he's presently Director of the Policy and Planning, as I mentioned, he's also involved in the Inuvialuit Environmental Review Board which is disassociated from government, and he's responsible, of course, as part of his job for the environmental evaluation duties, to co-ordinate GNWT interests.

We also have John Bekale speaking. John Bekale was born in the Territories at Port Radium, has lived in Fort Franklin, Rae and the Rae Lakes. He served as Chief of the Rae Lakes community and is presently vice-president of the Dene Nation. He's been there since 1973. Mr. Bekale has been a hunter and trapper since a young boy, and has worked in the mines and construction industry in the Territories.

Dave Nutter, who is the General Manager of the GNWT Chamber of Mines, tells me that his closest association with water is through his canoeing and kayaking activities. Professionally though, he's a geologist. He spent ten years roaming the Arctic as a mineral exploration geologist, and most recently has come from Pan Arctic, or from Pan Ocean Oil, excuse me, where he was manager of Environmental and Regulatory Affairs.

Don Gamble is presently with the Rawson Academy of Aquatic Sciences, however, before this, Don has had a

long association with the North. He lived in Yellowknife for a number of years in the 1960s and 1970s, he has worked with Department of Local Government, DIAND, AESL, an engineering consulting firm out of Edmonton, and I think the bulk of this period was with the Berger Inquiry. Subsequent to that he was five years as a Director of Policy Studies at the Canadian Arctic Resources Committee out of Ottawa. Over the last five years he's been with the N.W.T. Water Board. Somewhere in there he spent two years in Alaska as Chief of Staff for the Alaska Native Review Commission.

And last but not least, is Glenn Warner, and Glenn, of course, has a very, very long association with the North. He came up here with the RCMP sometime in the 1940s. I haven't confirmed that with him. He retired from the RCMP and became associated, or founded Bathurst Inlet Lodge, which is a naturalist centre, and since 1979, Glenn has been Chairman of the Northwest Territories Water Board. And I've been told that's the longest running period as chairman, either in the Northwest Territories or the Yukon.

Anyway, having introduced everyone, I'll now call on Ron Livingston to make his presentation.

R. Livingston: I guess I'd just like to start by thanking Brian Olding for giving me a call last week and asking me if I wanted the opportunity to say something today. And then he asked me what I would like to say, and that was probably the toughest thing to come to grips with. I'm not a technical water person, and my address today will be very short. I diligently prepared a formal address, but the more I read through it, the less I really felt like giving it to you.

What I'd like to say today is that within, the GNWT Water Management maintains a very high priority, and within our department, while we don't have the mandate or jurisdiction in the area of water management, we have over the past number of years worked to develop more credibility in the area and to represent our government's interests on resource development projects and in related issues dealing with water management. We have maintained seats on committees like the Mackenzie River Basin Committee and on, I guess, committees involved in other water management negotiations.

You're aware that our water resource up here is significant in the Canadian perspective, and particularly with one of the largest watersheds in North America, I think it's very important to the GNWT interests. In that regard, I think we are in a very unique position up here; while the water management issues are becoming more

complex we're still at a fairly early stage in development. I think a few years ago we were a little more concerned at the rate of development in the North, and while that scenario has changed, I think we should just use a bit of the breathing room we have now to take advantage of it and obtain the proper water management information that we need and work towards a sound water management policy in the North.

Those are, I guess, really the two things I'd like to just bring you up to date on, and that's the water policy initiatives that we have undertaken as a government and jointly with the federal government, and secondly, to comment briefly on the transboundary water management negotiations with the provinces. These two initiatives, first of all with the Water Policy Initiative. In 1984, our Minister formally announced that this government would be working towards development of an N.W.T. Water Management Policy. That address was made to the Pearce Commission. Subsequent to that, we have done extensive work in reviewing water management policies in other jurisdictions, and subsequent to that, formally began to work on this initiative with the federal government, and at the present time, we have developed a draft discussion paper towards a water management policy for the N.W.T. That discussion paper basically has the water management issues as defined by government, the rationale for a policy in the North, and the basic policy elements in terms of water management, principal goals and objectives. And I think that we've often talked about integrating land and water management in the North and having the opportunity to do the job right, we are really looking forward to getting that document out for full discussion, Canada-wide, and to the major interest groups in the North. That discussion paper has gone through the bureaucratic process in both the federal and territorial governments and will be released in the next week or so. We had hoped to polish it so we could distribute it at this conference, but when you're working within two governments, it takes even that much longer. But again, I just have to reiterate that we, having that luxury and that opportunity, we really want to do it right and develop a sound water management policy for the North.

And again, tied to that, subsequent to that, is the adequate information to implement that policy. Once the discussion paper is released and goes through full consultation, we will be meeting with the native organizations to get a perspective on their interests with regard to the implementation of the policy, as they have defined interests in water management through the land claims negotiations.

With regard to the interjurisdictional or transboundary water management negotiations, again, because of the

interest in the Mackenzie River basin, in 1978 the Mackenzie River Basin Committee was set up to basically obtain information and assess issues related to the Mackenzie River basin. And, I guess in 1981 one of the main recommendations coming out of the report was to initiate bilateral discussions between the provinces and the territories with regard to an agreement through which transboundary water management issues such as minimum flows, flow regulation, water quality, could be addressed at transboundary crossing points. Subsequent to this, we've initiated discussions with Alberta and have held two or three meetings to date, basically setting the framework for dealing with the issues identified in the recommendations. Alberta is in a unique situation in that they have both upstream and downstream provinces that they are going to have to deal with. It's of critical concern to the Territories, being the ultimate downstream recipient, and I guess a couple of years ago with the potential Liard Project and the Slave River Hydro Project, we were quite concerned at that time that without an agreement in place, we're not in a very strong position to negotiate water management issues. And I think there have been and probably will be future proposals for water diversion for southern needs.

I think a positive approach is the establishment of water management agreements as opposed to ending up in sort of a more formal court process depending on the extent of the concern. So, right now, we've initiated discussions with Alberta. Saskatchewan has identified its interest to also initiate discussions. We've sort of formally communicated with them, and those discussions will begin this summer, and the Yukon has expressed an intent to initiate those discussions as well. We still haven't had any success with committing British Columbia to the process, but we're hoping that will change.

I guess with that, the only thing I can say is the timing of this Workshop is going to benefit both processes that we're involved in. There is a need for a water quality monitoring strategy in the North, and with that I'd just like to say that again, while we as a territorial government aren't involved and we don't have the technical capability, we do provide all of the support that we can; we definitely support the initiative and the work that will come out of this Workshop. Thank you very much.

D. Nutter: Just by way of introduction I will make one comment, correction. I was introduced as being General Manager of the GNWT Chamber of Mines. Actually, it's the N.W.T. Chamber of Mines. We try and maintain some independence from government. We're not an arm of the territorial or federal government.

In reviewing the need for water quality monitoring in the North, from the industry perspective, I'll perhaps start off by just discussing the industry briefly, describing it to you, and I should also point out, as was noted in the introduction, that I'm a geologist by background and don't have a good deal of personal expertise in the area of water quality monitoring programs, etc., but hope that I'll be able to represent the interests and concerns of the mining industry here, as I've learned from discussions with our members.

Again, to begin with, some background information on the mining industry in the N.W.T. Mining is the largest private sector employer and second only to the government as an employer in the N.W.T., and is the principal source of what we term new wealth creation in the North. Currently, there are eight operating mines in the Territories, three lead/zinc operations, two large gold operations - sorry, three large gold operations and two smaller ones. There are also at least three mining operations which have been operational in the past and are currently on a stand-by status pending improvement in economic conditions, primarily a rise in price of such commodities as silver, gold and tungsten.

There are also a number of significant prospects located across the Territories which we hope to see in production in the next several years. Several fairly major gold properties within one to two hundred kilometres north and northeast of Yellowknife. As well, we have a specialty metals rare earth property about sixty miles east of

Yellowknife, which is quite exciting to the industry, and we hope we'll see into production, and there's a uranium prospect in the Keewatin area, which again may well see production before the end of this decade.

The Territories is the fifth largest metal producer in value of production in Canada. It produces approximately 7% of the value of production in Canada, and this is quite a remarkable achievement, given the fact that we only, in the N.W.T., have about 0.2% of the population of Canada. So we're a very productive society up here. We produce about 13% of the gold in Canada and about 27% of Canada's lead and zinc production. And up until several months ago, we were Canada's prime and essentially only producer of tungsten.

The presence of mining in the Territories has a number of major economic and social impacts, particularly in the areas of employment, revenue to all levels of government, and development of infrastructure. And we believe that mining really is a significant factor in the economy of the Territories. Mining essentially consists of three

operational phases: exploration, development and production, exploration being the search for and hopefully the location of what will eventually become economic mineral concentrations. Secondly, we have the development phase, which essentially is the phase in which we construct the facilities necessary for the extraction of the mineral product which has been discovered, and thirdly, the production phase, which consists of the actual mining and extraction of mineral product, hopefully at a profit, and delivery of that product to market.

The mining industry recognizes the need for and actively engages in water quality management programs in each of these three phases, but particularly in the second and third development and production phases. From the industry's perspective there are perhaps three compelling reasons, or needs, for the development of water quality management programs, or monitoring programs, and I should say, for the collection of water quality data. These three reasons, I would suggest, our three needs, are a societal need, a regulatory need and, unfortunately, a defensive need. Contrary to popular belief, at least in some quarters, the mining industry is not a faceless monolith without soul or conscience, but rather we're a collection of individuals who live in the North with our families, and thus we share the same concerns of all northerners regarding the health and well-being of our environment, and the environment in which we live and work and play. Thus we seek the optimum in water quality, and we recognize the need for ongoing monitoring of our aquatic environment to ensure that the water quality standards demanded by a well-informed society are met.

Secondly, in addressing the regulatory need, under the Northern Inland Waters Act, water users and those who discharge waste products into the aquatic environment must obtain authorization in the form of a water licence. This is issued by the Water Board, in our case, the Northwest Territories Water Board. And I think that our speaker later this morning, Glenn Warner, will be able to fill you in perhaps in much more detail on the function of the Water Board and the licence issuing process. But I'll briefly summarize it here.

The Northern Inland Waters Act is the primary legislation in this area, although there is other legislation such as the Fisheries Act which also regulates our water usage. The mining industry is a water user. The mining industry does discharge water into the environment following its use in the industrial mining process. This water generally is altered in some fashion, be it chemically, physically or bacteriologically, as a result of its use

in the mining operation. Thus mining by virtue of its water use and effluent discharge falls under the mandate of the Water Board, and the Water Board will issue a licence - well, we anticipate that upon application and upon meeting certain terms and conditions, the Water Board will issue a licence governing the proponent's use and disposal of water.

In order to commence full-scale mining operations, and in some cases at a much earlier stage, a prospective developer or proponent must apply for and be issued a water licence by the Board. Essentially, the proponent is obliged to initiate water quality monitoring well in advance of submitting a licence application and will continue with this water quality monitoring program throughout the life of the operation and the licence to ensure compliance with the terms and conditions of the water licence.

And thirdly, just touching briefly on the defensive need, this compelling need for water quality monitoring on the part of the mining industry is unfortunate but is a real result of the sometimes confrontational and suspicious environment in which we all live and operate. It's not unusual for industrial water users to find themselves held up as responsible for all manner of environmental ills, both real and imagined. I don't mean to pretend that the mining operations have no environmental impact, but it's important to examine and measure this impact from a number of perspectives. Firstly, in absolute terms, and that would probably be most familiar with all of us in the measurement of metal contents, pH, etc. Secondly, from the perspective of actual impact on the receiving environment, specifically the impact on fish, aquatic invertebrates and their habitat. And thirdly, from a perhaps subjective perspective which weighs the identified potentially harmful impacts on the aquatic environment in the context of both economic and social needs and demands. And what often results from this examination is a political decision made both by politicians and by society which determines the direction and pace of industrial activity, and just what impact will be permitted on the environment.

As a result of all three of these needs, the mining industry recognizes the need for the acquisition of baseline water quality data well before the commencement of mining operations, establishing a base standard for the characteristics of both the site specific and regional aquatic environment. Water quality data collection, as I said, continues throughout the life of the mine in order to measure both the absolute change in water quality, as well as the impacts of any such change on the receiving environment.

Just to briefly describe the licencing process, and again not knowing the text of Glenn Warner's speech later this morning, but hopefully he will give you more, better informed information in this area than I'm able to, but the proponent, the mining industry proponent who anticipates commencement of a mining operation will start off with discussions with various regulatory officials and members of the Technical Advisory Committee to the Water Board, to identify water quality data which are needed and programs that should be carried out to collect those data. And as a result of these discussions, the proponent will collect baseline water quality data both in preparation for the submission of initial environmental evaluation, and these data will also be attached to the licence application.

Following water licence hearings and anticipating - I'm here anticipating the issuance of a water licence - this licence will contain a number of terms and conditions regarding water use and regarding the disposal of effluent and these conditions are meant to govern the impact on the receiving environment which will result from this water use and discharge. And as a result of the issue of the licence and the terms and conditions attached to it, the proponent will continue to carry out studies which will have several purposes. One, to characterize the waste to determine if the tailings treatment process which has been proposed and put in place by the proponent and the operator - sorry, to determine what impact that process will have on the receiving environment and to measure that impact on an ongoing basis.

Secondly, the studies will determine if the tailings treatment process which has been proposed and utilized will generate an effluent which will meet the discharge and water quality criteria set up by the licence. So the proponent will establish a number of water quality monitoring stations in a variety of locations starting upstream of the actual industrial operation and then at various locations throughout the industrial operation, and again downstream of that operation, to measure the impacts on the environment. These water quality monitoring networks will include stations at the freshwater intake, in the tailings pond, measuring the end-of-pipe effluent from the tailings pond, and again, as I say, downstream. Also there may be water quality monitoring of tne sewage lagoon at its outlet and, if applicable, if the minewater discharge does not go directly into the tailings but rather directly into the receiving environment, that will be monitored as well.

I think in summary I'll mention that the government regulatory agencies are well informed of industrial

activity in the North, and mining activity in particular, and should be aware of what data are available and what data would be required to carry on with wise environmental management of the aquatic environment. The mining industry supports the water quality monitoring process, but stresses that it's the quality of data rather than quantity that's important. It does appear that there's often a perception that information requirements are dictated by regulatory agencies based on the perceived ability of the proponent to provide those data on the anticipated, either the present or the anticipated size of operation, and consequent wealth of the proponent. I think that we need to stress quality rather than quantity. It's important that both industry and government work together in the acquisition of water quality data, with the joint objective of maintaining optimum quality in the aquatic environment. Thank you very much.

H. Eisenhauer: What amount of quality assurance do you, as a proponent, have to provide to the regulatory agencies to ensure that your data are of proper quality?

D. Nutter: Mr. Chairman, with your permission and with the agreement of perhaps some members of the audience, I'd like to turn that question over to a representative of one of our operating mines in the Territories. Something I should note is that most, if not all, of our operating mines have environmental staff on hand on a full-time basis who run these monitoring programs as well as many other environmental management programs. And Hugh Wilson from Echo Bay is in the audience and deals with this on an ongoing basis and, if I may, I'd like to ask Hugh to come up and answer that question, because it's certainly not something which I deal with on an ongoing basis.

H. Wilson: With regard to the quality of our data, how valid our numbers are coming out of our various labs. I'll only speak for Echo Bay ourselves, at our Lupin lab. We are in the process of getting it approved by the Board and, in fact, we have been using our lab to produce our numbers for the Surveillance Network Program. We also carry out checks with a private lab to see how our numbers are being compared. We have also just established a joint program with the Northern Affairs Program Water Lab, here in Yellowknife, to carry out a monitoring program on the receiving environment over the next year or so, mainly because they want to get some numbers from their own lab and they don't seem to have the resources to get up and get the samples themselves.

But to answer your question, I would just reverse it and ask, what is the quality of the data coming out of your labs? Because I think ours are done and approved and the

labs at - if a company does not have a lab on site, they are using labs that are accredited in the south which have all the technologies and equipment that an Environment Canada lab would have wherever it might be. So, I guess, we are quite competent to answer your question, we are quite competent that the numbers we produce at Lupin are as good, if not better, than some of the numbers that can be produced from one of your labs.

D. Nutter: I think, if I may respond as well, because I'm not sure that we were attempting to get into a debate of whose numbers were better, but more the water licence which is issued by the Board will set out in some detail the water quality terms which, water quality standards, which must be met and will essentially set out what levels, what pH, bacteriological, heavy metal content, and other mineral content levels which are permissible in discharge from the operation. And these are set out quite specific to each licence, and it is then incumbent upon the proponent, or the operator, to show, on an ongoing basis, to the regulatory agency that these licence terms are being met. And they will do that both through use in their own labs as well as other independent labs, and will collect on a regular basis from a water surveillance network water samples as well as - this is perhaps getting away from water quality, but as well as biological samples from the receiving environment to ensure that the terms and conditions of the licence are being met on an ongoing basis. Does that answer your question?

R. Kwiatkowski: In terms of metal monitoring in the water, we have a number of various forms that we can monitor for. Total, extractable, dissolved or the nebulous biologically available. In terms of your requirements I'd like to know which one of those forms you actually monitor? Which ones do you feel should be monitored? And what mechanism is available to you to influence the Northwest Territories Water Board into collecting the information that the mining industry feels is the best, most cost efficient and will indeed protect the aquatic environment. As you have stated, you live here and therefore you also are concerned with the protection of the aquatic environment.

D. Nutter: Just, if you wouldn't mind just staying there so in case I get hung up in responding you can restate part of your question. To deal with the last part first, to put it bluntly, the only mechanism we really have is a lobbying mechanism which hopefully will consist of presentation of scientific argument as to which is the most valid measurement to be taking. And the mechanism we have, of course, is primarily tnrough the licencing hearing process, and both during the application of, the initial

licence application, as well as from time to time the operator may request an amendment to the licence, and again through the - well, both through discussions with the Technical Advisory Committee to the Board, as well as direct discussion with the Board during the hearing process, we are able to present our arguments in this regard. As far as what measurements should be taken, and again I'll say it in the context of not being somebody who's directly involved or has the direct scientific expertise, but again having talked to a number of operators and licence holders in the North who've gone through this process, there appears to me to be some concern as to what concentrations, what measurements, do need to be taken. You mentioned total available - I'm just trying to think -

R. Kwiatkowski: There's extractable, dissolved, total, biologically available.

D. Nutter: Yeah, right. Again, my understanding is that it's essentially the feeling of the mining industry that the measurements that should be taken, are those measurements of concentrations of metals or other toxic substances which actually are shown to have an adverse impact on the receiving environment. In other words, if you have a metal or, take the example of arsenic, going into the environment, which in a laboratory sense is measurable but in the environmental situation is actually insoluble and has no environment impact, or no impact on the receiving environment, then it would be our argument that that insoluble or non-impacting quantity should not form a part of the licence and should not be a measurement that is required. It may be a measurement which we take, but what is important, from our perspective, is that portion of the effluent discharge which actually does have an environmental impact. I think our principal concern is what is the impact on the environment. So, that has been a rather contentious issue in the past, and it's my understanding that in many instances water licences are still requiring the measurement and requiring the proponent to meet conditions which are based on total release into the environment rather than the release of environmentally significant concentrations. Does that go far enough in answering your question?

R. Kwiatkowski: Could I ask one more quick question Tom? Are you also required to do biological monitoring in terms of effects, either within the receiving water or bioassays of the effluent?

D. Nutter: I'm not sure. And I have read quite a number of water licences and my mind is going a little bit blank here. I'm not sure that within the water licence itself that we are required to, but I know for a fact that most, if not

all, operating mines in the North do carry out such studies, and perhaps that, as much as anything, reality would say that responds to the defensive need, one might say, that our concern being at some point in the future a debate may arise as to what the impact actually is. And we require, we feel that we require, a good database, a long-term database, covering that area. And, something just occurred to me as I was answering, that of course under the, say something like the Fisheries Act, I'm sure we should be required to be aware of impact and to minimize that impact. So, whether the Northern Inland Waters Act actually requires it, I'm not sure, and again someone like Arthur Redshaw or a number of people in the audience could better respond to that. But I know that we do carry out such studies, whether or not they're legislated.

T. Dafoe: I guess the question by Hugh Eisenhauer and the response by Hugh Wilson brought up a very important point. With respect to quality assurance and quality control in water quality data, perhaps it might be worthwhile to consider some joint program where both the, for lack of a better term, the government labs and the industry labs can somehow integrate their quality assurance, quality control procedures so that both could be confident of each other's results.

D. Gamble: Well, my remarks this morning are really designed to make only two points. And I hope that this will help establish the broadest framework for the information needs, at least as I see them, for water quality, northern water quality monitoring. The subject of water quality is really important. I don't think any of us doubt that. But I think, and it's been my experience, that there's a danger that we always face, and it largely comes from habits we've developed from the past, that we tend to view these problems much to narrowly. And my two points are basically these. First of all, that although the North is blessed with what appears to be good quality water in some abundance, the North and all northerners are much more vulnerable than most people realize. So the first point I'm going to make is about northern vulnerability with respect to water resources.

My second point is that the economic issues that face people here in the North, and they are very difficult economic questions, are all ultimately environmental issues. And if we are to learn from mistakes of the past, if we learn from the mistakes that we've made in the south, then what we need is not monitoring as we normally, or many people at least, normally see that in terms of effluent standards and water quality guidelines and the like. That's an inherently uneconomic approach. What must be developed here in the Northwest Territories

is an ecosystems approach to aquatic resource management. So my second point, after vulnerability, is the economic and ecosystems approach that should guide us in our discussions over this next few days.

Now I know it's been said many times before, and no doubt it'll be said many times again, but the Northwest Territories is once again at an important turning point in it's history. With devolution, particularly with the pending devolution of many water responsibilities, with major settlements of aboriginal title, and who knows even perhaps with division, there's an opportunity here in the North without equal anywhere else in Canada. This is the last great chance to do things right the first time: in social terms, settlement of native land claims; environmental terms, the acceptance of the dependency of all human affairs on a safe and sustainable environment.

Now there is an attitude here in the North that is only beginning to emerge in the south, because of painful lessons caused by things like acid rain and toxic pollution. People elsewhere on this continent and in most other parts of the world face an enormous uphill struggle to try to regain the kinds of things that are taken for granted every day here in the North. Now, having said that, it's my view that here in the North, and particularly with respect to northern water resources, we are very vulnerable indeed. And I see this vulnerability in three ways. First, I see a tendency, particularly in government, to ignore the hard lessons we have learned in places like the Great Lakes. There is a tendency to continue to apply outdated, cumbersome, institutional approaches to problems that we have come to see cut across mandates, jurisdictions and disciplines. So in the North, it is vulnerable because it may inadvertently inherit water resource institutions and attitudes that are not only irrelevant to the North, but they are largely irrelevant in most other places as well. Now I'll explain this further when I come to the points on the ecosystems approach.

The second vulnerability that I see is related to the first. Because the Northwest Territories is experiencing fundamental change with things like devolution and land claims, there is a danger that the baby could get thrown out with the bathwater. When making big organizational changes there is an unhealthy tendency to tinker and overhaul things that aren't even broken. What seems so tidy in the walled-in world of bureaucracies rarely has much to do with the real issues that people face in their day to day experience. I am thinking here of things like the moves over the past several years to fix the Northwest Territories Water Board. What was being fixed, or what was attempted to be fixed, often wasn't broken,

and what was broken, often wasn't being fixed. The vulnerability in all this, in my view, is that we may diminish or lose the things that are important to the future of aquatic resource management here in the North, and they're important because they have a proven track record and they work.

The third vulnerability that I see is due to an unfounded complacency that many people seem to exhibit because in the North water seems so abundant, and it seems so pristine. And I think a rude awakening is about to occur. And let's just look at the facts. First of all, as Ron alluded to in his remarks, the western Northwest Territories is vulnerable because a huge portion of its water comes from other jurisdictions. What happens when Alberta decides, in its own best interest, to alter the flow of its northward flowing rivers? Or what happens if development in Alberta, developments that we can already see for the next decade, alter the quality of waters that enter the Northwest Territories? And what about the Liard River and the Peel River? In political terms, the Northwest Territories does not wield a big stick. Northerners are going to have to be especially vigilant and especially clever diplomatically. With this outside threat, it is my view that the essential guarantees for the North will come to a large degree from the aboriginal title of the Dene, Metis and Inuit people that is now enshrined in the Constitution. That title, once clarified, and as has been demonstrated by work recently been done at the University of Calgary in the Institute of Resources law, bears directly on water.

Another fact. There's a vulnerability here because of long range transport of hazardous and toxic substances. The pristine North is largely a relative term. It's more myth than a fact. Acid rain is a curse in the south. It's something that we read about and hear about almost daily. But here in the North there are similar problems. Its effects can be alarming. For example, it is one explanation for the very high levels of PCBs found in mother's milk in women in the Broughton Islands. No other source can be easily identified. Pollution is drifting into the Northwest Territories, not only from the south but from over the Pole from Eurasia and elsewhere. This international dimension to the problem must guide us in our discussions this week, if we are to arrive at a sensible understanding of what is needed in terms of water quality monitoring.

Another fact. Water quality problems already exist here in the North. While they are relatively few and somewhat isolated, that is more attributable to a small population and low industrialization than to any inherently robust system of water resource planning and management. Now I

don't want to make, to be misunderstood, and to criticize the considerable accomplishments of groups like the Northwest Territories and many other institutions here in the North, industries included. But we surely can accept that where human activity has concentrated here in the North, problems have ensued. Look at Pine Point through the eyes of the people from Fort Resolution. Or consider the tainting of fish that happened a number of years ago in Hay River. And what about the people from Fort Good Hope and what has been discovered just recently, based on their complaints about the downstream effects of developments at Norman Wells. And look at the water supply and sewage disposal problems of communities throughout the North, and particularly in the eastern Arctic. The problems today are fairly small, but they suggest bigger problems in the future unless changes are made.

One final fact on vulnerability has to do with climatic change. There seems to be very little doubt in the scientific community that climatic change is inevitable, because of human impacts on global systems. If I can have that first overhead there. The North could be particularly hard hit, and the change will profoundly affect the water resources here within our lifetimes. These two maps were taken out of a recent publication of the International Institute for Applied Systems Analysis in Austria. Canada is a member of this Institute. And it illustrates rather graphically the long-term significance of climatic change. The top map - you don't have to worry really what the colours mean, it's just - I'm showing them both just so you can see the change. The top map shows life zone classifications for present conditions. The bottom map shows life zone classifications for doubling of the carbon dioxide, and you can see that the effects on the Northwest Territories are going to be dramatic, to say the very least. And this will have a profound effect on water resources, water resource problems, as well as a number of other issues here in the North. I'll maybe just leave that on for now.

Now, to this point in my talk I've been trying to explain what I see as the vulnerability of northern water resources. This vulnerability has direct implications for water quality monitoring, and I urge you to keep these kinds of things in mind over the next several days. Well, vulnerability was my first main point. The second point that I said I wanted to make had to do with an ecosystems approach.

The starting point for an ecosystems approach is to understand that all human activity, all enterprise, is dependent on the environment. Man is part of and not

separate from the ecosystem. Environment and economics are human inventions. They're two artificial categories imagined out of the same thing. In the past a lot of energy was put into economic activity, and developing cost effectiveness. And these kinds of terms remain popular today. They're popular concepts. And they're important. But they are generally narrowly conceived. Last year in its annual report entitled "Changing Times," the Economic Council of Canada itself raised environmental issues as fundamental economic issues. The environment in that report was characterized as the basic engine of growth, noting that all human activity, which is the economy after all, takes places within and is part of the environment. The recent report of the World Commission on the Environment and Development, the Brundtland Commission Report, which was released, I believe, last week or the week before last, makes the same point and calls for a new expanded economic era based on sustainable development. Annexe 1 of that report sets out principles for environmental protection and sustainable development. Those principles can be very easily implemented here in the Northwest Territories. And I suggest that they could form a very useful starting point for the kinds of discussions that I hope we can have over this coming week. And I've brought copies of that annexe with me, if people are interested.

Canada's representative on the Brundtland Commission was Maurice Strong. He recently characterized pollution as a cancer running through society. It couldn't be better said. We are in danger of killing ourselves. And nowhere is that more obvious than in water resources. Water is nature's great integrator, the medium of confluence for all our neglect and all our abuse.

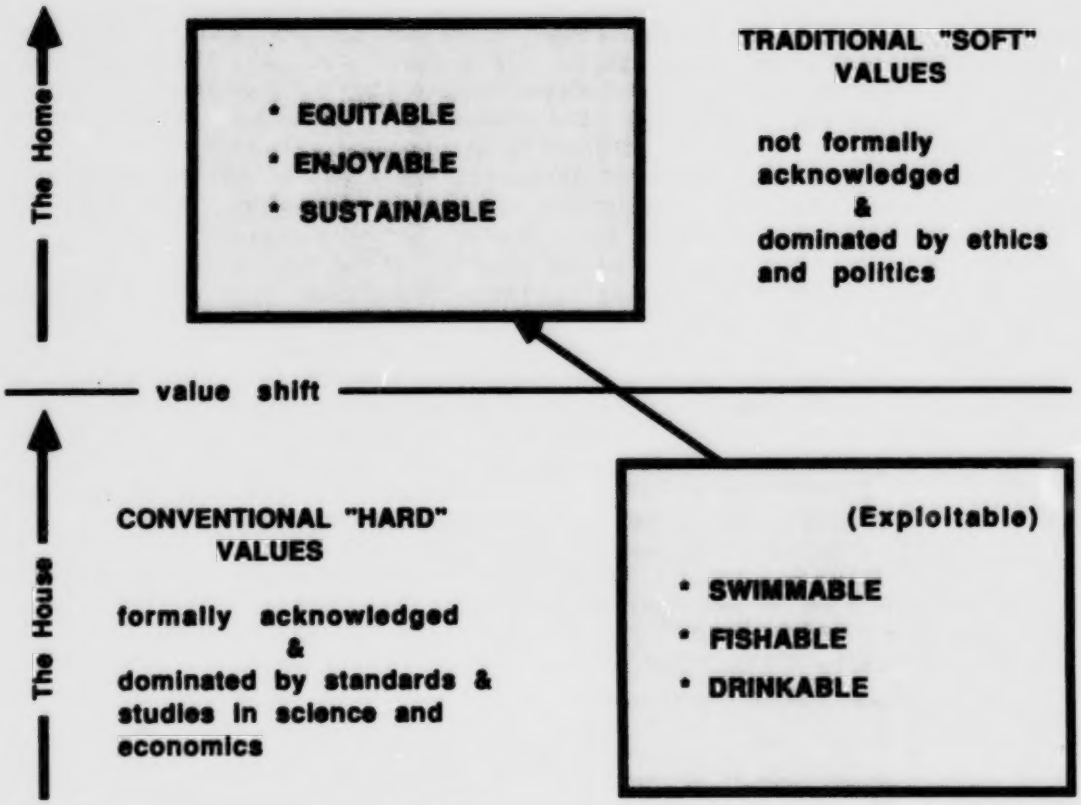
Monitoring water resources is monitoring the prospects for the long-term health of society. But that monitoring is not, in my view, characterized by sampling the water column, or even the end-of-pipe discharges. And I want to explain why I say that. If we are to understand what's happening, what things really mean, and what needs to be done, water quality data alone, and effluent regulation, don't take us very far. They help, but I would argue that that is not the way to come at the issue. And I'd like to cite the example of the Great Lakes, because it is the classic example.

The experience in the Great Lakes has shown that the current approaches to freshwater management are woefully inadequate. Well why is that? Dr. Andrew Hamilton, the Senior Environmental Advisor to the International Joint Commission (IJC), maintains with considerable passion that the problem is our present and past commitment to what he calls "pipe and technology standards." Better

approaches have been pioneered in some places, but they have run into a barrier of outdated conventional wisdom and institutional myopia. And Dr. Hamilton cites the Herring Gull Program in the Great Lakes as an example. As many of you know all too well, before it's 22% reduction, the Canadian Wildlife Service had a vital toxicology group. Part of the work that they were doing was the Herring Gull Program in the Great Lakes. That program monitored both the chemical residues in gull eggs and the health of herring gull colonies. That monitoring was essential to understanding water problems as is evident in the reports of the Great Lakes Water Quality Board, and the reports of the IJC. The Herring Gull Program was recognized as the best measure of progress under the 1978 Water Quality Agreement. And if I may quote Dr. Hamilton. In talking about the Great Lakes he said, "People want to know whether it is safe to drink it, swim in it, or eat the fish from it, and the herring gulls make an excellent barometer because they do drink it, they do swim in it, and they do eat the fish from it. Now, figuratively speaking, with the curtailment of the CWS [Canadian Wildlife Service] program, it seems that we are to be left with little more than a hollow shell of what was once the centrepiece and flagship of our Great Lakes International Surveillance program."

Understanding water resources, properly addressing the real as opposed to imaginary water resource problems, requires an ecosystems approach. That approach is called for in the Great Lakes Charter signed in 1985, in the Toxic Substances Control Agreement, and in the Canada-Ontario Agreement respecting Great Lakes water quality renewed in March 1986. The same kind of aquatic ecosystems approach is what must be at the very heart of any northern water quality monitoring program. What an ecosystems approach does is force us to address the true consequences of human activity. It is the economic approach. Instead of dealing with end-of-pipe issues, we must go right up the pipe to the process itself and to the demand that spurs the process. We must develop a proper accounting and management system. In the past, economic has become almost synonymous with the concentration of benefits and the widest possible distribution and deferral of costs. The ecosystems approach seeks to change that. And to try and explain what I'm talking about, for those of you who perhaps don't understand the ecosystems approach, I've made a diagram which I'd like to put up and to describe very briefly.

The aquatic ecosystems approach, the literature I rely on primarily, is work that has been put out by Dr. Henry Regier at the University of Toronto, and Dr. Jack Vallentyne, who is a senior scientist at the Canada



Aquatic ecosystem schema.

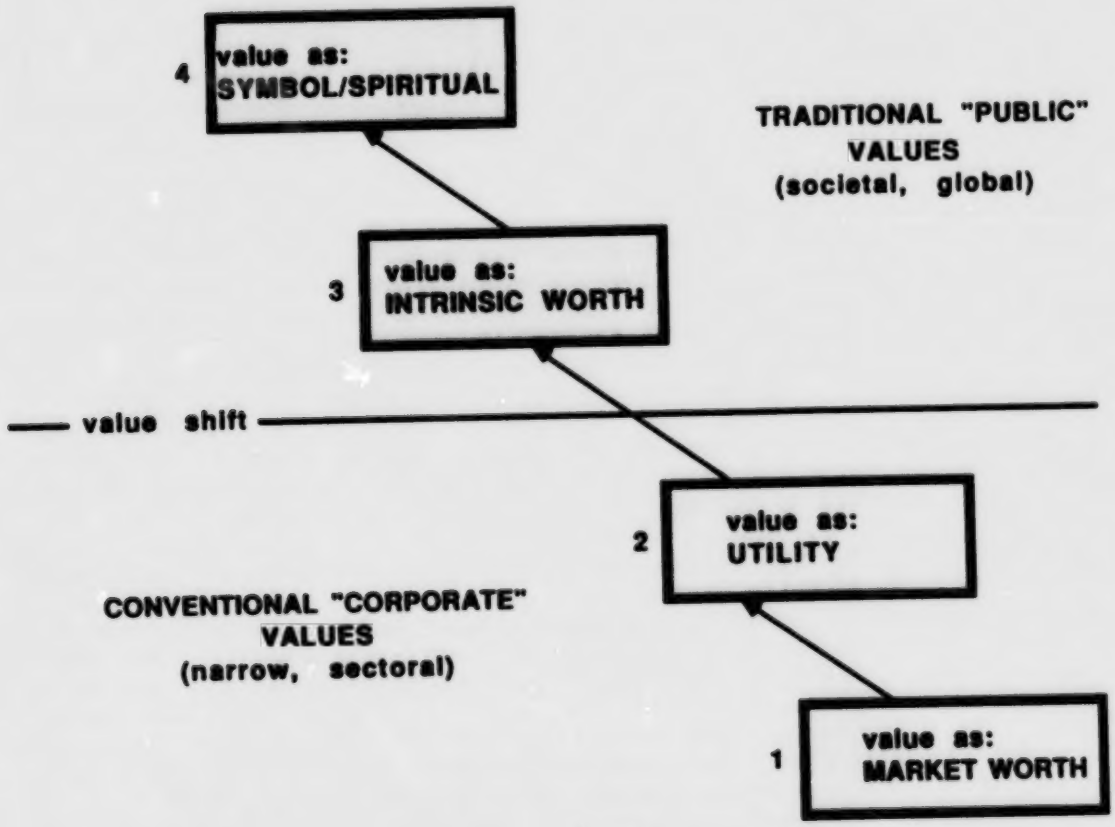
Centre for Inland Waters in Burlington. And it can be illustrated - this is my diagram, I can't blame them for this - it can be illustrated by this diagram. And basically, I've divided the aquatic ecosystems ideas into two parts. The lower part I've called the conventional hard values and the top part are what I call traditional or soft values. Now the bottom part, Dr. Vallentyne has characterized as the house; the top part is what makes the house a home. And I think it's a useful way of seeing the two. It's a very powerful analogy.

In the bottom part we see what has in the past been formally acknowledged and what's been largely dominated by standards and studies, by rules, regulations, even the kinds of things that the Water Board produces. And these are things related to whether the aquatic resource is swimmable, drinkable and fishable. In other words, they're the human approach to the problem based on exploitation. But there's an important value shift which takes place, and this is the kind of thing that is being pushed by things like the Bruntland Commission Report, that we must go much beyond that now, to the values that

are a little less quantifiable, and that's why I've called them soft. They have not in the past been formally acknowledged because they're dominated by ethics and politics. And these are the home values, using

Dr. Vallentyne's term, and the kinds of things related to what is equitable, what is enjoyable, and what is sustainable.

Now I'm not saying that this is an easy transition to make, and that's why I have the value shift line in there, but this is the kind of value shift that is now taking place if you read carefully the kinds of agreements that are being formed around the Great Lakes, the kind of scientific research, and the monitoring programs. They are more and more designed to what is ultimately going to be sustainable and equitable. And it's this kind of challenge that I think is the one that we should address over the next several days here in Yellowknife. We can either get out ahead of the problem, or as in the Great Lakes, we can be forced many years from now to react to it and try and fix it after the fact.



Four classes of values.

Now this movement from house to home is the kind of thing, at least as I understand it, that the native people have been trying to say all along. It fits directly into the kinds of things that we see emerging in the agreements in principle, in water issues that have been signed by native organizations and the Government of Canada. And it illustrates the increased public perception of values, not just in terms of short-term market worth or utility but more as the intrinsic worth and the deeper meaning, and in some cases, particularly as I've heard it from native people, the spiritual meaning of what the environment is. As a society we are moving from outdated views exploited water resource management, decision making, to new views that spring from a knowledge that we are dependent, a very small part of a much larger and apparently more intelligent system.

Now this ecosystems approach has yet to penetrate corporate and government institutions of decision-making. But this is changing, and in time it will change even more. Through concerted efforts of each one of us here this week, I hope we will be able to pioneer this change for the Northwest Territories. After all, the time is ripe here, and there is no better place to demonstrate that it can be done, and it can be done right. Much more needs to be said about this approach obviously, and much more needs to be said about the vulnerability of northern water resources, but I hope in these very few comments that I've made, that I've at least begun some thinking about how we can approach this problem anew, and how we can, as I said at the beginning, take the opportunity to do things right the first time here in the Northwest Territories. Thank you very much.

D. McNaughton: When you say that one of the important things is - the value shift you're talking about there. How do you see it in light of the fact that we live in a consumer society and consumerism is considered to be sort of the be-all and end-all and the means by which people measure their wealth, I should say their worth, in a society? How do you see turning that around before the landfill sites eventually cover up all the earth's surface and garbage barges cover the ocean?

D. Gamble: I haven't got a quick answer to your question. If I did, I suppose I wouldn't be here. There is no quick answer. But what I'm trying to point out, and using the Great Lakes as an example, is that we don't have a choice. The choice is being forced on us, and the most compelling current demonstration of that kind of situation is the Brundtland Commission report. Any reading of the Brundtland Commission report can't help but stop somebody solidly in their tracks and to begin to ask very

fundamental questions. And the first question is, how do we start turning this around? We're facing that in a local way in the Great Lakes. Everybody understands that this is a very difficult problem; that we cannot continue the way we have in the past. Fundamental changes are necessary.

The question then is, well how do we start to do that. Well, governments are responding. The Water Quality Agreement is a response. The kinds of monitoring activities that have been undertaken now in the Great Lakes are trying to get a better handle on how we can best go about the problem. Certain kinds of regulations, which a decade ago were completely unheard of related to the tracking of toxic chemicals from cradle to grave kind of thing, are a response to that kind of thing. And I think we're going to see more and more of that kind of thing. If you look internationally you can see moves towards compulsory recycling of products. These kinds of things are all geared to make the economic system sustainable. In other words, in the past we've simply been drawing down our capital and paying no attention to the long-term health and wealth, the kinds of things that we're going to leave to our children and to future generations. That is changing; the change is being forced on us in the south, and in places like the Great Lakes.

In the North, what I'm arguing is that rather than wait for those things to come and hit us over the head, we can get out ahead of the issue. Instead of going at it in a reactive way, we can make a proactive approach. We know what the problems are going to be, fifteen, twenty years from now, in the North if we keep going in the same way. We know the difficulties in having water issues fragmented between a whole host of different jurisdictions and people with different mandates. That need not happen here in the North. And if you look at the kinds of things that are being envisaged in part through native claims, and rumours I hear about what possibly could happen with water resource issues when they're transferred to the Northwest Territories, I see it as an opportunity to pull things together the right way the first time so that we don't have to try later to patch things together and cobble together solutions to problems as we're doing in the Great Lakes region.

J. Bekale: Good morning, gentlemen and ladies. First of all, I meant to speak this morning, but my schedule changed and I didn't come, I was late. But I'd like to talk about the Dene who live in the North. We've lived off the land for a number of years, and we still do today. Living off the land means a lot for native people here in the North who do a lot of trapping, hunting and fishing, and the

first thing we do is always look out for the environment, especially not over-harvesting the animals, nor over-harvesting the fish. So that's what our native people do. Seeing those changes in the years of having the development come to the North, and seeing a lot of those changes, and again even with our native people in Fort Good Hope, notice changes in the fish. And not just that, there are other changes throughout the valley here. With the fish, the animals, and I guess it's important for us to get involved and especially the native people who know and understand the land, who understand the fish, they understand the animals. And what we're doing right now is going through claims, we call land claims.

There, we're trying to be able to achieve somehow ourselves being part of the management structure of wildlife, and I think most of all we're most interested right now in water. And I think that's what is being discussed here. Water, I think, native people see those changes, see water, how the river is, where it started from. Where I come from, Rae Lakes, it's mostly all lakes, there are a lot of lakes in there; there are rivers in there, and I think with our people seeing those different changes, I think it's time we feel we're capable of being part of this management. And through land claims, hopefully, we can achieve that in trying to be part of this management, we can look at the water, the animals. I think it would be a great help to the North here if native people could take part in those things, because any changes here in the North, in the land and the water, we notice it right away. With those kinds of things I'm sure we'd be able to bring our expertise into being involved in those things. And seeing those changes in those years, I guess where I come from, Rae Lakes and that way, there are a lot of mines that have been abandoned. And from that you can see those different changes. And I think a lot of our people can tell you that, and since development is sure going to be coming to the North, I think it's time our people here in the North start getting involved in management, especially in water, where we can go away ahead of where development starts coming to the North, you know, trying to protect the environment. That's our first priority for native people, protect the environment.

And I think throughout the years that's the first thing we try to do is protect the environment. With all things that are going to be happening here in the North, we'd like to be a step ahead, especially being involved in this management, especially looking at water, and I think that's what we'd like to do. Again, there are different studies going on. There are Porcupine caribou herds. Right now the native people in the Yukon are asking to do

a study on the caribou to see if they've been affected by this radioactivity, especially from Russia. Of what happened over there and being compensated to those people for that purpose. And again it's happened here in the North. I think that's what the Yukon native people are trying to do. I'm sure we're mostly interested in looking at the caribou here too, because that's the major food that we have for the native people. Everything affects the caribou, like the water. So I think that's the kind of thing we'd like to do here in the North as native people. Be part of those things. Involve ourselves in those managements; be involved in those different panels if there are any. That's the kind of thing that native people are looking at.

Through the years I think people in the south look at the native people as opposing all development. I don't think it's in native people's mind right now to do that. It's to protect the environment. That's the first thing the people would like to do; to make sure there is some kind of monitoring happening before anything would go ahead. Make sure there's safe use of water, no chemicals go to the lakes, the rivers, that's the kind of thing that people like to see done. We don't have in the North right now some kind of water management, and that's what we'd like to see in the claims. I think because we're great users of the land, we'd like to protect the land, and especially the lakes. I guess my ending speech would be we'd like to be involved. We'd like to be involved in all aspects of management, and we'd like to get ahead of all the development that's coming up North. And I know exploration is going to come North. The mining industry is coming North, but most of all there are a lot of abandoned mines and places like that, I think, that our people are most worried about right now, especially what happened on Rayrock Mine. I think that's the kind of experience that a lot of native people are looking at right now and saying, look, if we can't get ahead of these things, make sure if any mining comes North, that we make sure we're involved so we can protect the environment so they don't abandon those mines and leave them there, and destroy the fish, the water, and the land. And I think that our worry right now is those things. And I guess we'd like to be involved ourselves.

When Bob MacQuarrie's going to speak here. He talks about constitutional changes, and I think that's another thing that native people like to see is those changes here in the North, especially in the constitution, where we can be able to involve ourselves, and that's something maybe Bob would touch on, but the native view is to change those things we can involve ourselves. We've done that through land use planning, where we involve ourselves. We're trying to involve ourselves in land use

planning, and planning in the North. Native people would like to see those changes, and like to see our involvement. I'm sure Bob will probably mention the constitutional changes here in the North. He's going to talk about division, but I think the native people must be involved in this whole issue of division, constitutional changes, and especially in claims. Hopefully, we can be able to involve ourselves.

G. Warner: Good morning, ladies and gentlemen. It's a real pleasure to be here, with a water-related group. As Tom said, we wear a lot of hats, but the one with the water in it is near and dear to my heart, and we'll follow on from the excellent presentation of Mr. Bekale from Rae Lakes, but the Water Board won't take the rap for Rayrock Mines as it was in production before we were. But we are standing here and we'll take the rap and, indeed, should be accountable for anything similar that happens after the

Water Board was constituted in 1972. So, we are accountable, and in the phone book. And now that Mr. Arden came through the door, if we included ex-member Don Gamble, we even have a quorum here today, so we could make some decisions if necessary. For those of you who don't know, Arthur Redshaw back there is a father of the Northwest Territories Water Board, for better or for worse. I don't know whether Arthur likes that, but he's been around longer than any of us. And, of course, Dr. Brian Wilson and D'Arcy Arden are here now, and Don Gamble was a valuable member of our gang for five years.

So a little background on the Water Board. Unlike some of the departmental mandates, we have a federal statute, the Northern Inland Waters Act, which sets up the Northwest Territories Water Board and the Yukon Water Board, so we are backed by statute and responsible to the Minister of Indian Affairs and Northern Development. It's a rather broad mandate. The objects and powers of the Board are to provide for the conservation, development and utilization of the waters of the Northwest Territories, for the people of Canada and for the people of the Northwest Territories, in particular. So, it's sort of an ongoing struggle between the Board and the Department whether this is sawed off just on a licencing program, or whether indeed we're involved in the planning and the monitoring and the whole process. And I think probably we've outlasted or outfought or outlived anyone that quarrelled with this. It seems that no one else is doing it, so the Board can take on any mandate that it likes, and we're very fortunate, in addition to a lot of northern, long-time northern and native content on the Board, we have some top notch scientific expertise and, of course, Brian Wilson and Arthur Redshaw are two of them.

One of the interesting things of the Northwest Territories Water Board is that we licence both water use and waste disposal. In a lot of the provinces, people do one or the other, but to my knowledge no single board in the country does both with the decision-making powers of the Northwest Territories and Yukon Water Boards. I say decision-making even though the Minister of Indian and Northern Affairs is the man that signs the licence into law, he does not have the power to change a condition in a licence. And since this Board was established in 1972 the Minister of Northern Affairs has never failed to sign a licence issued by the Board.

The membership is made up of regional, ethnic, scientific and government people. Three of us are appointed by the Minister of Northern Affairs upon the recommendation of the Legislative Assembly, and that's D'Arcy Arden, who's here with us now, Frank Ikpakohak from Coppermine, and myself are all nominees of the Government of the Northwest Territories. The three appointed members, because of their federal affiliation, although it's important to note that everyone sits on the Water Board as a private member, are Arthur Redshaw, Brian Wilson and Dr. Tom Jeyachandran. And the other members are appointed at the Minister's pleasure, if you like, Bill Case who's a long-time mining man; Letha MacLachlan, a Yellowknife lawyer, and Doug Billingsley, who knows a lot about reindeer and other things in the Mackenzie Delta.

So that's the background on the Board, and on to something that's probably more timely today, on research and monitoring. The Board believes strongly that research is needed to develop a better understanding of northern aquatic ecosystems and how they function under normal conditions. Research is needed to develop a better understanding of how northern ecosystems respond to contaminant loading. Research is needed to provide input to northern developers and regulators, so as to enable sound development. And the planning and input predictions are necessary to those of us in the regulatory business to make worthwhile and proper decisions.

Monitoring is needed to develop a reliable and useful baseline of ambient water quality, to enable long-term tracking of broad water quality trends; to enable site specific evaluations of development impacts; to provide a timely and effective feedback system for regulatory agencies like the Water Board. Perhaps I'll get off on a little tangent and talk a little more about timely later on, but we'll see if Brian smiles at me or not.

The Water Board concerns - regarding aquatic research and monitoring in the North, there is little initiative by

researchers to bring research findings to the attention of regulatory decision makers. And I'm sure this is not an opinion that is completely shared by all, but this is a Water Board opinion. Much research and research funding are justified on the basis of current regulatory issues, but the research results seldom appear until long after regulatory decisions have been made. And for those of you who follow the CARC [Canadian Arctic Resource Committee] newsletter, you'll remember a several page blast after the Beaufort Sea inquiry was completed and timely is the name of the game, ladies and gentlemen. Those of us in decision-making roles, with industry on one side and the environmental and scientific community on the other, if we're going to take your advice and consider it, in the way that it should be taken and considered, we have to have it in a timely fashion. Industry, and I wear both hats, industry does not have the luxury of time. They have deadlines to meet; they have flowthrough money to spend in this fiscal year; they have shareholders pushing on their door; and believe me, there are, contrary to a lot of belief, the Northwest Territories is not to developers the land of milk and honey. There are a lot of other very worthwhile places in the world where these, I'll say the mining people, for instance, but oil and gas as well, can spend their money. There's Australia; there's Nevada; there's California; and there are lots of other good places in the world. So if we want to be competitive, and I don't stand alone on this, the northern mineral policy just published has said northerners and our government leaders must promote development. We must have your advice in a timely manner, if we're going to have it to help us make good [environmental] decisions.

Just to keep you up to date on the new things that the Water Board is doing. I think most of you are familiar with our Technical Advisory Committee that gives us technical recommendations on licencing and, indeed, any other matter that is referred to it by the Water Board. We do have a recently constituted Environmental Advisory Committee. Just a little background on this; it is certainly pertinent to what we're doing here today. The Northwest Territories Water Board has established an Environmental Advisory Committee to assist and advise the Board on matters relating to water quality standards and environmental impact monitoring. The objectives of this committee, generally speaking, are to advise the Board on the following five points, although not restricted to this: monitoring issues and priorities; monitoring guidelines; environmental sensitivity; water quality standards; water management and planning. And while the membership of this committee still is open and open-ended in the sense that there's room for more, it presently included the Department of Indian Affairs and Northern

Development, the Government of the Northwest Territories, the Department of the Environment, the Department of Fisheries and Oceans, Health and Welfare Canada for environmental health, and the native organizations, the Dene Nation, the Metis Association of the Northwest Territories, the Inuvialuit Lands Administration have supplied us a member, and the Inuit Tapirisat of Canada through the T.F.N. [Tungavih Federation of Nunavut] have been part of our committee. Last but not least for Hugh down there, the Northwest Territories Chamber of Mines is on it, and the Arctic Petroleum Operators also have a seat on this committee. So, as you see, it's heavily loaded in favour of government, so we count on those from outside government to speak with a strong voice to make their case, and I think the people we have there do that.

In my mind, the most important part of this committee is the fact that it is chaired by Ron Livingston, a senior person with the Government of the Northwest Territories. This is the first time that the GNWT and us feds, if you like, have done something like this together. The Water Board is federally constituted, although you know the make-up of the membership now. But with the Government of the Northwest Territories now taking the lead role in our Environmental Advisory Committee, chaired by Ron Livingston, we see this as a real step to cover all bases and to go in the direction that all of us want to go. And certainly our friend from Rae Lakes and the other organizations that we have talked about, if they want more input or more involvement at any level, at our Technical Advisory Committee or our Environmental Protection Committee, or indeed on the Water Board, we are open to these suggestions and have had some success in making things happen.

In conclusion, I would just like to tell you that in the ten years that I've been around there, and probably the twelve that Arthur has, we do believe that the Northwest Territories Water Board is an effective decision-making tool. Not perfect by any means, but like some of the governments that come and go, nobody seems to know a better system right now so they put up with us. And most of us have many, many years in the North, thirty plus lifetime members for many of them, and we live here in Yellowknife and we are accountable for our decisions. Sorry about that, we don't all live here in Yellowknife! Frank Ikpakohak in Inuvik and some of them would take exception to that.

So the Water Board works well. We have had a lot of success with keeping everyone reasonably happy. I guess if anyone was ecstatic about it we wouldn't have the proper balance. But everyone is reasonably happy and we are here to stand before you and defend our decisions,

and I come back again to timeliness of your input, so we can make good, sound environmental decisions. Thank you very much.

Discussion Period, Session 1

R. Allan: I wanted to make a comment on what Don Gamble said, and maybe it'll start a bit of a discussion. A few weeks ago at a Science Advisory Board meeting, Jack Vallentyne asked us all why we thought the ecosystem approach in the Great Lakes had not been implemented that well in the Great Lakes basin. And my answer to him was the ecosystem approach - now Jack's not here to defend himself, so I maybe shouldn't say too much about this, but I said that one of the problems, I think, with the ecosystem approach is its complexity. Now I agree with what Don has said. Philosophically, the ecosystem approach is a great idea. It's a great umbrella to sort of put everything else under, and it's a great goal to aim at, and on our Science Advisory Board we have a Mohawk Indian, from the St. Regis Reserve, who also thinks the ecosystem approach is a great idea. So I think it goes along with the native people's idea of how man should live in harmony with water and with nature and that sort of thing, and I'm sure that we all philosophically agree with all of this.

I guess my criticism of it is, how do you actually implement the ecosystem approach? And this gets very difficult, and also because it's a very philosophical sort of thing, I think to some extent senior government officials, certain scientists and all sorts of people find difficulty in grabbing onto it and knowing where to go to actually implement it.

The other thing that Don said that I agree with is that to some extent the old way we've gone about things by setting standards and guidelines may not be the best way to do things. I'll give you an example of this. In the Great Lakes Water Quality Agreement, it calls for zero discharge of all persistent toxic chemicals and metals. Yet we spend a great deal of effort designing guidelines and standards for Great Lakes water quality. To some extent this is an interim approach, but I guess the bottom line is that the agreement still calls for zero discharge. So at one end, you've got a way of monitoring, setting guidelines and standards. At the other end, you've got this philosophical idea that we will all benefit by looking after the environment and therefore the economy and environment are linked together and so on, which is the ecosystem approach. I think the real answer to a lot of this, that most of us in this room would like to see happen, is something in between the two. And to go back to the Great Lakes example

again, I think this has happened in a couple of situations.

One example is where an industry has an effluent going into, say, the St. Clair River or the Niagara River, which is a huge flow. It meets all the standards and guidelines, especially if you take into account limited mixing zones which nobody's quite sure how big they are. So it meets the criteria that are required. On the other hand, the downstream effect and impact show up in gull eggs and in fish and all the other things. So how do you really control that? The regulations are met, but if you go in there and you start finding various chemicals that are shown to bioaccumulate, that are shown to get up to the top of the food chain, there becomes a sort of pressure on industry to clean up their effluents. And I'm not going to mention the companies that did this, but when they do that they find that it's not economic to go and take out one chemical in a huge effluent, so you really start to shut off the total effluent, or you start to clean the whole thing up, and you maybe take out all of the chemicals at once. So that approach is the approach that's now in vogue in Ontario under the new MISA [Municipal and Industrial Strategy for Abatement] program. And I think that's a way, when you tackle effluents, you can get a much bigger return in terms of reduction of pollution in the environment. Effluent control based on a research approach and also on monitoring is a way that you can tackle pollution and start to see some real improvements.

Another thing in the Great Lakes that happened recently is the remedial action plans. Cleaning up areas like Hamilton Harbour. Now you could take Yellowknife Bay as an example of this. If you had a remedial action plan for Yellowknife Bay, what would you do? In the case of Hamilton Harbour, we have public meetings, we have the public involved; industry is involved; the governments are involved, and they try to come up with a way to clean up a very polluted area. That's a real specific example of trying to clean up a very polluted site. There are some very polluted sites in the Northwest Territories, and maybe some of those could be approached in this way. Now, if you tackle it that way, then you know where you're going to go and how you can eventually try to reduce problems.

Now, as Don said, it is after the fact and it would have been maybe nice to philosophically 70 years ago before industry got going in the Great Lakes basin that everybody realized all this, and we didn't have to come in after the fact, and I think that's what he was trying to get at as far as this area goes. But I just wanted to point out that you've got to have a practical approach to

how to tackle the problem. Maybe I can ask Don just how would you go about tackling it on the basis of the ecosystem approach, rather than in terms of specific objectives.

D. Gamble: You're right, you've identified a problem. The ecosystems approach is a philosophical approach. It's a way of looking at the problem. It in itself does not tell you how you must structure a program, how you must build a bureaucracy or even exactly what it is you should go out and start to monitor. So, we're not in disagreement there. However, without a philosophy, without a broad context within which you try and understand what you're doing, things start to come apart. They get fragmented. And what the ecosystem approach does, it can be implemented early, as I'm advocating that it be done here in the Northwest Territories. For example, in the development of a new water policy for the Northwest Territories. If it can be done, it provides at the beginning a sensible framework within which then all the aquatic resource issues can be properly addressed.

And so the kinds of problems that you describe, with Dow Chemical and the St. Clair River, and in the Great Lakes, are - it's not that they won't happen, but that we stand a better chance of catching them early. The three key words I see in developing an ecosystems approach are enjoyable, equitable and sustainable. What you describe in the case of the St. Clair River is not sustainable, it's not equitable, and it's not enjoyable. Now, what does that mean in more specific scientific terms? What it means is that somebody in the long term is going to have to pay for this. And that ultimately the other resource users along that river cannot sustain themselves. And so we must look at this as a much broader problem. This isn't just a problem of measuring effluent at the discharge pipe. It isn't just an issue of having somebody sample the water as it's flowing down the river. It isn't just a problem of sampling fish, and seeing what's happening there, or even the herring gulls for that matter. It's understanding what's driving that process. Understanding whether we can sustain that or not.

Now, I know that I'm being a little bit vague here, and I'm being vague because I am vague about some of these things. But I know I'm right. And the reason I know I'm right is based on past experience. If you look at what's happened in the Great Lakes, if you look at what's happening globally, just read that annexe that I referred to in the Bruntland Commission report. We've just got to stop pretending that we lie outside the environment. That somehow we're isolated from what we're doing to it.

And just because an effluent doesn't appear to have measurable impacts on the environment in the sense of water quality does not mean that it does not have an effect. As you've pointed out for the Great Lakes. The Great Lakes is the classic example to show why effluent standards don't work, and why water quality guidelines don't work. We're doing work now in northern Quebec with the Inuit there. There's a terrific mercury problem. Mercury is showing up in fish at ten times the safe level for human consumption. It doesn't show up in the water column. Anywhere. But we know where it's coming from. So if you were sitting there measuring mercury content in the water column you get nothing. In the meantime, it's a serious health hazard for the people who rely on that resource. Something has to be done.

So taking this broader ecosystems approach will help in that. If a water policy could be developed for the Northwest Territories, which insisted on the sustainable, equitable and enjoyable use of aquatic resources in the Northwest Territories, that almost becomes the constitution around which we then can build the infrastructure that can support it. It's the place where you start and from that flow a whole bunch of things. Is it practical? I don't know if it's practical. One definition of practical that I've heard, I think it was Disraeli who defined a practical man, as a person who you can count on to perpetuate the mistakes of the past. So we've got to break with the mistakes of the past, and the way to do that is to start conceding these problems in this broader context. And for those things, for that approach, I rely on things like the Bruntland Commission report, on work like Dr. Regier is doing, the work that the International Joint Commission is involved with now in the Great Lakes, and many, many others.

L. Lockhart: First, a comment, not as long as Rod's. I think it was mentioned that in the North this is a time when we might prevent some of the mistakes of the south. My comment is that we're already too late. We're not going to prevent some of the things that are happening, because the North is part of, certainly the hemispheric system and the global system larger. But that wasn't my purpose for seeking the microphone.

I wanted to ask, I guess probably Ron Livingston, about the current thinking for oil and gas development in the Territories, and what implications it might have for water issues. I recognize that the projections might vary almost daily with world political and economic considerations, but he may be in the best position to tell us what the current thinking is.

R. Livingston: I guess in response to your question I think scenarios vary quite a bit. I guess for our department, we're presently going through a strategic planning exercise and from my discussions with different people, they have been painting more of a doom and gloom scenario of fairly low development. Personally, and I guess partly from my involvement with the Inuvialuit Environmental Review Board and the proposed Amaulagak project in the Beaufort, which is a fairly large project, approximately a billion barrels of oil, with seasonal production. I guess, because of that and because it's a major economic production that within three to five years I see a fairly major or more extensive oil and gas development scenario underway in the Mackenzie Valley and in the Beaufort. I guess parallel to the Canadian oil and gas development are the proposed developments you may be hearing about on the Alaskan-Yukon border, which is approximately 4.8 billion barrels of oil. And so, I think, because of the extensive reserves that are potentially coming under production in the next few years, that we'll see a fairly large-diameter oil pipeline down the Mackenzie Valley, and I would say within three to five years. And because of that economic find you're going to tie in a lot of other smaller developments which will become economic.

R. Kwiatkowski: I'm not sure if I can formulate this into a question. I think my biggest difficulty with the ecosystem concept is that it functions, as Rod Allan indicated, at the theoretical level. Unfortunately, government spends incredible amounts of time and effort into fragmenting its various departments into categories, even within the aquatic environment, we have Fisheries and Oceans and we have the Water Quality Branch with the Department of Environment. They have been able to segregate out sub-components within logical units. This causes a great deal of difficulty in this concept of communication on a horizontal basis so that we can make proper decisions in terms of managing the water resource. Perhaps in the Northwest Territories this problem may be resolved because of the small number of people you have here. A number of you get to wear different hats. You can wear your government hat one day and you can show up at the Northwest Territories Water Board the next day and wear another hat. In the south very rarely are individuals allowed to wear more than one hat.

In terms of the ecosystem concept that Don brought up, does the Water Board, by virtue of it's name, look solely at the medium water? Are you making efforts to look at this larger picture of atmospheric input, land use activities and integrating these within the basin to look at the whole unit? I don't know whether you should change your name to Northwest Territories Environmental Board or what, but somehow the very fact that you're

called the Water Board makes me wonder if you have not fallen into that trap of fragmenting yourself into a unit and having another unit taking care of the other components of the environment. Who is going to do the integration? I'm not sure who should answer that, but maybe Glenn, you could start.

G. Warner: Sure Roy, I'll take a shot at that. And it's a very good question, no doubt about it. But as we say in our preamble to every public hearing into a water licence application, water is the only business of the Board, so economic and other matters that may be related to a development are beyond the scope of the Board and must be dealt with in other forums. And I think that we'll have to say that at the moment the same is true of the land and the air and even the ice. We have a vast network of winter roads here in the Northwest Territories, and to date, the Water Board hasn't gotten involved. And I think at one time when Vince Steen from Tuktoyaktuk, when he was mayor there, phoned and was unhappy about a condition in Tuk Harbour, I think, whether or not Tuk Harbour is under the jurisdiction of the Water Board is something that lawyers could argue about. But as long as things are being done well, we haven't gotten involved.

And in the bigger picture, I do believe that it will be the Government of the Northwest Territories that will pull things together. But this, again we get back to a lot of the political things, and this is what makes things happen in the Northwest Territories. A lot of things are not going to be co-ordinated as well as we would like until land claims are settled, and this is a fact of life. The people involved in the negotiations are more content with the status quo than something that they don't know about or have a lot of input in. So things will progress in an orderly basis, but I do believe that it will be the GNWT. Maybe I'll ask Ron to speak on this afterwards. They're coming out with a Water Policy. We have a Land Use Commission. We have a Science Advisory group that looks at broad environmental things. I think that the GNWT is the catalyst that will put the whole ball of wax together. Ron do you want to take a shot at that?

R. Livingston: All I can try to give you is a GNWT perspective on it. I think, with regard to the ecosystem approach, it is a philosophical approach and it's pretty hard to argue with, and I think what we're trying to do, at least the work that we're doing in the Department of Renewable Resources, is basically linking, right down from the world conservation strategy, which is a very broad statement in terms of how to achieve sustainable development around the world, towards work in the Territories to develop a northern conservation strategy,

and link that with other jurisdictions, the Yukon, Alaska, circumpolar nations, to develop circumpolar conservation strategy, and then once we can agree on the common goals, is to achieve that and I guess in order to implement it. We talk about integrated management, and the work that we've been doing lately is to define what, in fact, integrated management is. And really, I call those tools by which to achieve sustainable development.

Integration, I think, has to occur right from the policy down to the legal end of things. This involves, in the North, setting goals and objectives; these include socio-economic environmental goals, setting policies in place, using processes like land use planning to integrate decisions, and an efficient, effective management system. And I think what's happening in the North now is we have a number of different jurisdictions and with land claims involved that in terms of the management institutions that will be developed, I think we have to be innovative and creative and try to come up with a system that represents the different interests and yet achieves our goals of wise use.

H. Wilson: Just some comments to Mr. Warner. First of all, I'd like to commend the Board for establishing the Environmental Advisory Committee. I think it's a good approach, especially when you're dealing with water quality standards and environmental impact monitoring. What I believe the Committee will do is provide a draft identifying these two areas, or addressing these two areas for your approval, and industry is encouraged by these initiatives, and hopefully it will decrease expenditures in these areas to industry.

Having said that I must also state that industry is aware that monitoring is a requirement and part of doing business in the N.W.T. We're not saying that we're anti-monitoring, but I think this approach will minimize the amount of monitoring that is required. Again, I think that we want to emphasize the quality of data as opposed to the quantity of data. Past experience has indicated that at times requirements have been on the quantity and not the quality, and I think that this committee will guide the Board in a better direction.

Monies spent by industry in excess of a minimum acceptable database are removed from the industry's ability to expand its current operation or develop new properties for development. Your comment about the N.W.T. not being the only game in town is a very good one and I'm glad you brought it up. My question - do you see a change of focus of the Board dealing with environmental impact monitoring requested of industry, to encourage development but maintaining a quality that is acceptable

and do you see the Board's approving and funding research and development programs independent or in co-operation with industry?

G. Warner: Thank you for the nice comments and the tough question. I don't see any change in the direction of the Board and I don't personally see any need for change in the direction of the Board. Since the inception of the Board the licences written by the Board have been as strict or more strict than anywhere in Canada, and perhaps broader than that. And certainly a lot of places that were contaminated prior to the Board's arrival, we have worked on diligently to clear up.

I'd sort of be interested somewhere later on to hear - I think the fellow from the Science Institute said that there are several very polluted sites in the Northwest Territories. I wouldn't mind hearing a little more about those other than the obvious tailings ponds where all this pollution is. I'd like to say that our Northwest Territories waters are as clean as they ever were and perhaps getting better instead of moving the other way. That's a pretty broad statement. Not many people from the scientific community would make a statement like that, but not being so blessed, I can.
And this is not just any sort of praise for the Water Board, but the people on there really work diligently on behalf of the people of the Northwest Territories, and all of Canada, to keep it that way. So I really personally wouldn't want to see a change in direction. But what we do hope for from the Environmental Monitoring Committee is to give us some guidelines, certainly to improve the quality of data and if quality will replace quantity, good for us, because we all know it costs the licencees a lot of money to take a lot of samples at short intervals and have them analyzed, and Brian Wilson could tell us a good deal about the quality end of it and the data that the Board would like to see. In fact, did that in Fort Rae the other day when Neptune Resources were talking about the data, so I hope that's vague enough that it'll confuse everyone, but we do have high hopes from the monitoring group, Hugh. Believe me, the thrust of the Board is to encourage development in the Northwest Territories and employment for our northerners and all Canadians, create wealth, but keep our waters clean. I think the business card of any members of the Northwest Territories sets it out very well. You might ask one of them for one at lunch. Thanks.

G. Packman: I have a quick question for Glenn Warner if I may. Do you think that you're getting the kind of information that you need from the government agencies? Do the Board members feel that they're getting that, and do you have any ideas about how we might be able to provide the kind

of information that you need? Can you make any kind of comment on that?

G. Warner: I think, generally speaking, Glen, that the Board is satisfied generally with the information we're receiving from government, because we're not bound to only government. We're not restricted to government departments. We can go to outside contractors; indeed we do a lot, to get other opinions. The only criticism I have, I was shouting about it a little bit earlier, and it's I don't think even a criticism. It's just a fact of life. It's the timeliness of the material, because it does come down to the crunch and whether we like it or not decisions of go or no go have to be made, and if we don't get the information in time it can't be part of our decision-making process.

L. Lockhart: In the regulation of inputs, it's much easier to deal with a specific development and a source that you can apply some regulatory control to. With some of the things that are now beginning to appear, certainly in the fish and in the marine mammals of the Territories, they're not really subject to regulation within a territorial government structure. PCBs were referred to. I think people of the Territories are going to hear a lot more about toxaphene, about chlordane, about hexachlorobenzene and about a number of stable pollutants that are appearing at levels in the low to mid-part per million range, where consumption of small quantities of tissue can raise some questions about the safety to the consumers. I'm thinking of blubber, of blubber oils, of fish oils, and I'd like to ask what concepts of larger regulatory tools that the Territorial Government might have, because the sources of these materials are outside Canada and certainly outside the Territories. I don't perceive of a good structure to deal with these pollutants that move internationally. The radionuclides from Chernobyl are a very recent example. But that phenomenon has been known since the strontium 90 days, indeed since the explosion of Krakatoa volcano in the last century. And it seems that northern hemispheric peoples have to think beyond the ecosystem even to a global scale and I wonder if a body like the Water Board could be a force to promote that kind of thing, at least within two levels of government.

G. Warner: Lyle. I'm going to defer to my friend Mr. Gamble, but I'm going to give him a minute to get his act together. Maybe some thoughts too, but his act. Because he's plugged into the broader picture more than the Water Board is. I don't think the Water Board's reluctant to do anything that is within our aims and objectives, and God knows those are broad enough. But whether or not we want to do it or whether or not the people want us to do

it, maybe, again I defer to the GNWT as being the catalyst to do all this, but as we all know in the meantime life has to go on until all these other good things happen somewhere down the road. Whether it's one year or five years, life has to go on. So Don is well plugged into the Northwest Territories. Do you see anybody here that could do that, Don, and how would you set it up?

D. Gamble: In the remarks I made I tried to point out very briefly that there were threats to aquatic resources in the Northwest Territories that come from outside the Northwest Territories, and that's basically the point you're making, and without saying who should do what, the first thing is what needs to be done. I had hoped by raising it in my opening remarks that that kind of question about what needs to be done could be addressed during the next several days in terms of monitoring, at least. Now beyond monitoring, obviously there are regulations and other institutional and legal mechanisms that have to be put in place. It is my understanding that already the Science Institute of the Northwest Territories has been considering looking at these issues that you're raising, and how they could assist in developing solutions and even monitoring, I understand. Now I don't know how far that's gone, but let me come back to the basic point, and that is what needs to be done is the issue we have to address first. Once that's clearly stated, then who should do it is relatively straightforward. It's not straightforward about how you're going to fund that.

The Northwest Territories Water Board, we have to understand, was created in the 1970s, and at the time, it was the result of the very best thinking people could bring to bear on water resources use. And I think over the years the Water Board has proven that it's more than met the expectations of that time. The kinds of problems that you're talking about are the kinds of things that are now becoming, I hate to say it, but popular, scientifically anyway, and they may require revisions. It may be that the Water Board's mandate does have to be broadened. Maybe the Water Board does have to be given other powers. I don't know that. Until people can tell us what it is that needs to be done or can be done about the kinds of problems you're raising, these international problems. The export of pollution into the Northwest Territories. Those other things can't be addressed institutionally. Does that go some distance?

New Speaker: I guess it's more a comment than a question, and I'm kind of addressing it to Don and Dave and Glenn up at the front there. We've been talking a bit about our mistakes in the past, and I pose the question, can we learn from

them and have we learned from them? And I appreciate Don trying to set some direction on the conference, maybe we can put together some technical basis for deciding what we measure technically and how that is involved in the decision-making process. What I'd like to say is, we have to make mistakes. Theoretically, that's how we learn, and we either take some risks and go along and learn, and as Don just mentioned, back in 1972 they set out a mandate that was the best thinking at that time. Maybe 10 years or 15 years later, now is the time to do that again.

I had a question, the same question that Rod Allan brought up, how do we implement it. I think we need to have a starting system from which we can build and learn, and the timeliness is a tough question too, because a lot of it, we're going to be building knowledge up as we go along, and we can't answer all the questions at the start. But the question I guess I'll pose is one that Don basically avoided, but who will pay for us to learn and what mistakes are we going to have to make in the process, and will the Northwest Territories Water Board support research with dollars? Will the Chamber of Mines support research with dollars? Who's going to pay for it? How are we going to implement it? Because it basically comes down to, without the dollars to do it, it's not going to get done.

D. Gamble: Well, let me answer the latter part of your question first. The question of who's going to pay. The fact is we're paying anyway. And the Great Lakes is the best example. I keep coming back to the Great Lakes because it's the worst case scenario in a sense. And if you want to see what goes wrong and how it goes wrong, and what the consequences are, then look at the Great Lakes. And the costs of clean-up are horrendous in the Great Lakes. The cost of prevention, by comparison, if we could have gone back to the beginning, would have been much less. And so what I'm basically saying is let's look at prevention by the constructive use of regulation and everything else, policy, now, so that the "who pay" question doesn't ever really have to come up. At least to the magnitude that it is in the Great Lakes. But let's not kid ourselves, that somebody's paying for it anyway. It's the downstream user or you could say the environment pays in the short term. In the long term, if it's carried on, then ultimately it requires some sort of clean-up and that's usually expensive.

Your broader question was, how do we do this? And that's why I said that what's happening now in the Northwest Territories is almost tailormade to allow us to do it. We're looking now at the Northwest Territories and creating a new Water Policy. The draft policy, according

to what Ron said, will be out shortly. It's a draft. We've an opportunity to constructively criticize that, see if we can't improve it. Where else in Canada in an area of comparable size anyway, with comparable water resources, are we starting with that kind of openness, and the ability to build in a constructive way. That not only has policy opportunities, it also has institutional opportunities. The kind of policy that will come out will allow us to create institutions which are much more responsive. So what happened in 1972 with the Water Board can be re-done now in the 1980s and 1990s in the Northwest Territories, in a much broader sense.

The transfer of jurisdiction over water resources to the North, from Indian and Northern Affairs, and from at least parts of the Fisheries Act, is again an opportunity. It's an opportunity for the Territorial Government to avoid the kind of fragmentation that's caused problems in the past. So that's another how. There's another opportunity there. The settlement of land claims also is an opportunity, and I think they're one of the best long-term opportunities, because what will happen with the settlement of land claims is that certain approaches, or certain things will become constitutionally enshrined. And it then becomes immune from any kind of tinkering, because it happens to be a little bit inconvenient or even a little bit expensive. So if we get that right the first time, I think we've got a much better future ahead of us. So there are three examples that I think show that in the North there's a tremendous opportunity and a tremendous future ahead. It's just a matter of seizing it.

End of Session 1

Session 2
Water Quality Monitoring Activities

Session Chairperson: Mr. Paul Whitfield

Editor's Note: The presentation by Mr. Doug Stendahl, Water Resources Division, Indian and Northern Affairs Canada, was unavoidably rescheduled. However, in these proceedings, Mr. Stendahl's presentation appears at the end of this session.

P. Whitfield: The afternoon papers deal with ongoing monitoring programs and activities which actually gather data in the North. I want to capsulize a bit of what I hope we're going to hear this afternoon. This morning we talked a fair bit about these systems being very vulnerable. I think we need to talk more about the uniqueness of these systems, and the problems with transfer of technology from the south to the North. I hope we'll see some discussion of those kinds of activities, and I hope that some of the material we'll see will deal with the fact that these systems generally are in an extreme condition.

One of the things we tend to be finding in water quality monitoring in the North is that because these systems are extreme, they point out areas and clues as to how systems that are not in extremes work, and often there are some phenomena that appear in northern systems which are obscured in those systems in the south that are altered by man. We always have to be vigilant to watch for that in the data that are being gathered. Also one of the exciting things about working in the North is that almost all data which are gathered are new and exciting. One of the concepts that I'd like to leave you with is the fact that a lot of the information and the concepts that come out of the North are probably more transferable to the south than the other way around.

I'd like to introduce the first speaker, Brian Olding, who is with the Water Quality Branch in the Northwest Territories. Brian is going to talk to us about Inland Waters/Lands Directorate monitoring programs, and he's also going to briefly touch on Indian and Northern Affairs programs. The second speaker, Mr. Doug Stendahl, who is not here today, will be giving his paper tomorrow. Thank you Brian.

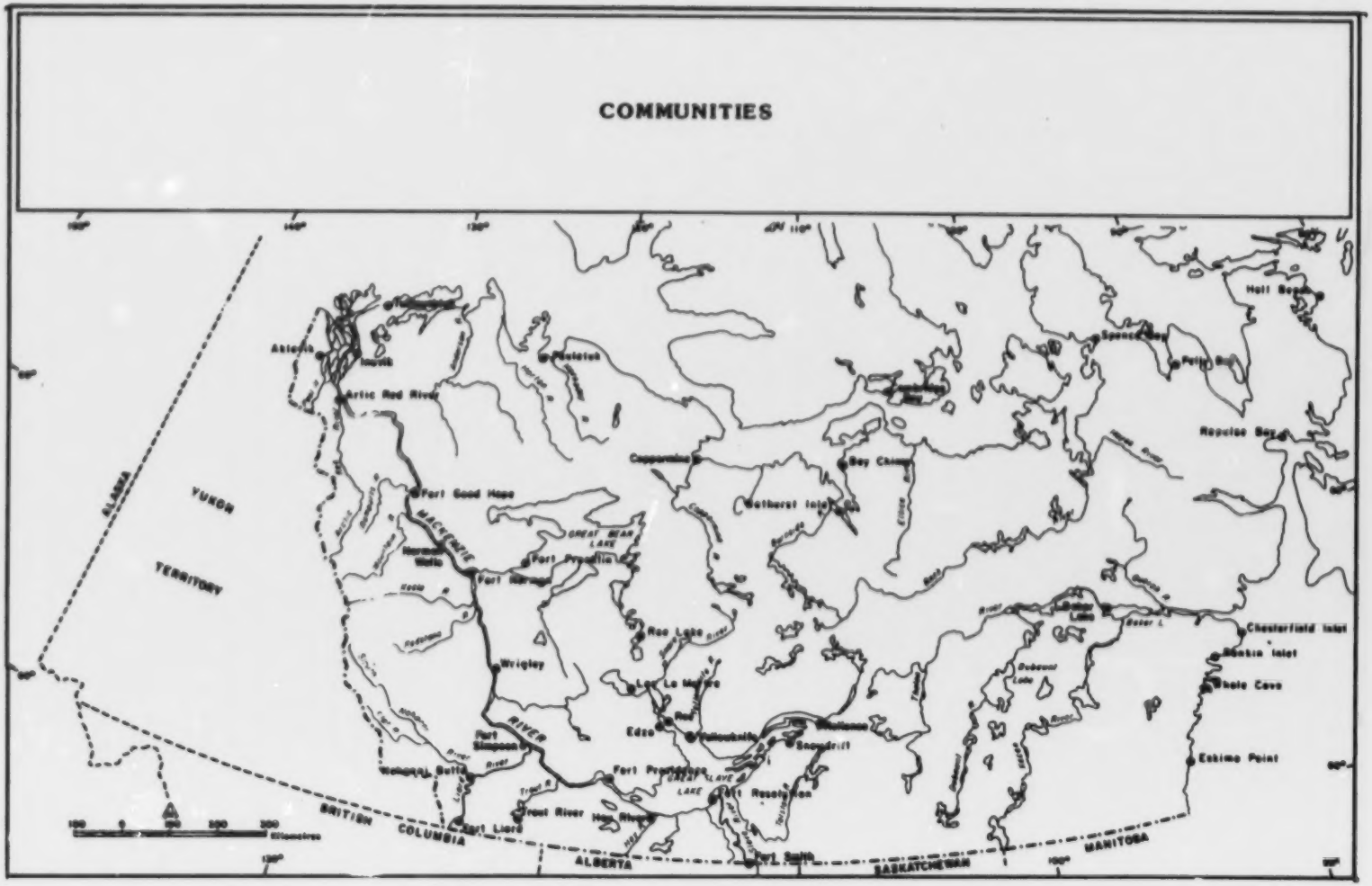
B. Olding: I'm with the Water Quality Branch, Northwest Territories, for Environment Canada, and what I'll do is quickly introduce who we are, what we do, our mandate, and I'll go down some of the monitoring activities that we're either carrying out or planning to carry out.

The mandate of the Water Quality Branch is to provide water quality information on issues of national concern, and what that means essentially is that for rivers and lakes we have to be able to go and identify what the current water quality situation is and be able to detect rising pollution levels if they should occur. The next question that people are going to ask is - the most common question we get from the public and even some other agencies - is the water okay? And generally there'll be some use they have in mind. That may be a drinking water supply for a town, or fisheries, which is very big in the Northwest Territories because of the native concern for fisheries. So we have water quality guidelines which we refer to, and that's already started some debate in here this morning, but it is our mandate to be able to identify whether or not the waters are suitable for particular uses.

Our focus is on ambient water, and what I mean by ambient water is - I'll define what it's not for starters. If we have a discharge, a point source discharge, either from a municipality, from a tailings lagoon or any other type of industry, you have a point source which is regulatory monitoring, which Indian and Northern Affairs would take care of in the Northwest Territories. You have a downstream mixing zone, and those two areas are what we do not preoccupy ourselves with. What we take care of is more of a broad scale, regional approach to monitoring, where we're looking at large systems and a number of cumulative impacts that may occur in a system, we'll keep tabs on it. So we'll be there before industry, hopefully, we'll be there after, but we're not focused on specific industrial discharges. We are looking at the overall system.

This is a map of the Northwest Territories, and I'll just give you a couple of little tidbit facts. The Territories is one third of Canada's land mass. The Great Bear Lake and Great Slave are in the top ten largest lakes in the world. The Mackenzie River system, depending on how you measure it against the St. Lawrence, is the largest or second largest in the country. We're dealing with a very large area in here.

I'll now go through some of the activities that have been taking place from a geographical point of view. In 1983, there were a number of registered complaints from some of the native communities on the Mackenzie River relating to the quality of their fish, specifically watery flesh of whitefish and discoloured livers from burbot. This coincided with other activities that were taking place at that time. The native population eat many of the organs of fish, so if they complain about the livers, that's important to them because it's part of their natural food intake.



Northwest Territories mainland base map.

A lot of focus was put on the oil and gas industry. The federal government released funds from the Northern Oil and Gas Action Program (NOGAP) for ambient monitoring on the Mackenzie River systems. We took advantage of some of that funding and we did not focus on any particular discharge. We carried out a survey from Fort Simpson at the top here, also the mouth of the Liard River, which will be important in a minute, and then went right down the river as far down as the delta, and our aim was to go and characterize the ambient baseline quality as far as hydrocarbons go in that river. It had not been done before. We carried out some work that was a first in the Northwest Territories in terms of suspended sediment monitoring. Now this work was actually done by the National Water Research Institute, which is one of the Environment Canada research arms located in Burlington. They co-ordinated activities with us, carried out the planning with us, and we got, I think, a fairly good study started out here.

What was done was that there's a pump off the front of the boat sucking water continuously from the bow of the boat and running it through this centrifuge, and then the water comes out the back. We did two things with that. The first thing we did was we took samples of the water coming out of the centrifuge, we ran those through a resin column and that gave us the water concentration of hydrocarbons in the water. The second thing we did was go and look inside the centrifuge at this bowl and that's collecting suspended sediment, the fines in particular. We took a look at those fines and analyzed those as well, which is not usually done. So this is not just monitoring of the water column, it's monitoring suspended sediment, and we found that the suspended sediment was carrying petroleum hydrocarbons as well. The main conclusions that we've got in a very preliminary sense - we've done two surveys now, one high flow in 1985 and one low flow in 1986. And what happened is we've identified above and below Norman Wells petroleum hydrocarbons and we think - this is a very preliminary result right now - that this is probably associated with natural seepage which has been reported in the river for a very long period of time. The other surprise, or the first surprise, was at the Liard, which was our control. At the mouth of the Liard we also identified petroleum hydrocarbons in that river as well.

There hasn't been much environmental planning done for the Liard River basin as a whole. It runs through a number of jurisdictions, so we took a quick run up through there by air, noticed an awful lot of seismic activity in the area, a number of gas plants in the Northwest Territories as well as in northern British Columbia. We can't draw conclusions from that right now,

but we know that there's oil and gas activity up there and we know that we've got petroleum hydrocarbons at the mouth of the Liard. How that affects the Mackenzie and what possible relationship there is between that and the fish concerns of the native communities, it's way too early to tell. What we have done is applied for funding to carry us through and go and repeat those surveys and see if we can duplicate the data.

Another activity, which we're planning right now, is the Yellowknife River Basin Survey. The water that's in your tea and coffee and in that juice comes out of the Yellowknife River, from the mouth of the river. The reason that we're in the Yellowknife River basin is a co-operative study, and there's a lot of interest between government agencies and the public in the Yellowknife River basin. It's a prime recreational area, it's a cottage country area. There are some abandoned mines in the Yellowknife River basin, the effects of which are at present unknown in terms of their possible leaching of metals into the system. As well, it's the water supply, of course, for the city of Yellowknife. So we're going up into the Yellowknife River basin in co-operation with the Water Resources Branch, which is providing flow information in the basin at different points. The Water Planning and Management Branch, which in co-operation with the Government of the Northwest Territories, is undertaking a socio-economic review and inventory of the basin, and for water quality we'll go in for two surveys: one in about a week from now and another in the fall. We will go and sample downstream from some of the abandoned mines to see if there is an effect on receiving waters. We'll also take a look at the tributary and the main stem and we will co-ordinate the monitoring at the mouth of the river with additional studies carried out on Yellowknife and Back Bay which are financed by Indian and Northern Affairs this year. Those studies are taking place out of possible concern for contamination of the bay and it may be considered a new drinking water supply source. Because of the lack of resources up here we have to scramble and basically get whoever is available to help us out with the work.

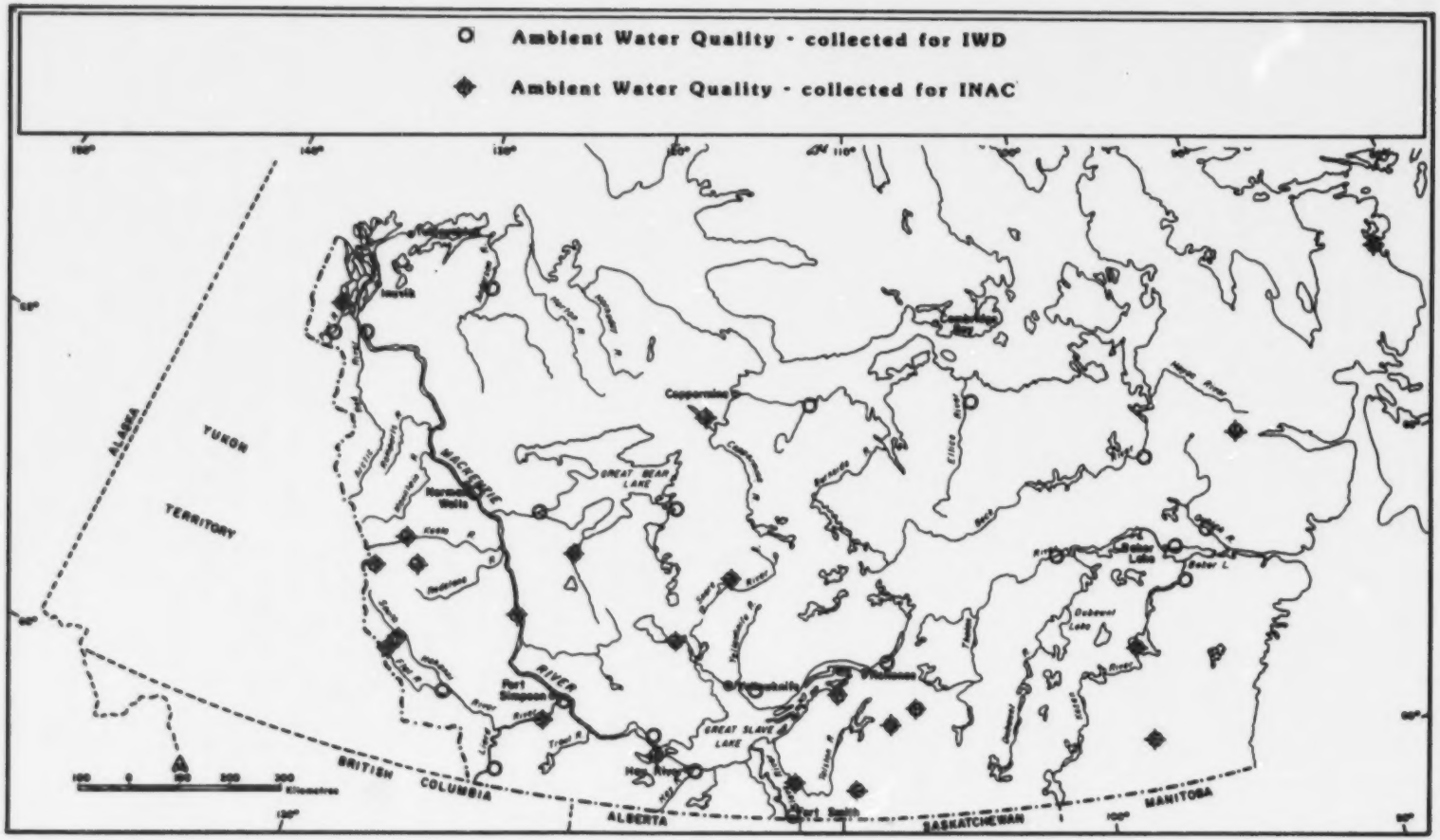
Another area that we're looking at right now is the Nahanni River basin. Nahanni is over in the mountains. There is a stream of cordillera running down on the western border of the Northwest Territories. At the lower bottom of that river basin, there is the Nahanni National Park Reserve. It's the world's first UNESCO heritage site. It's a national park reserve, and upstream of that there are two mining facilities, both of which are not currently in production right now. They are very dependent on the international commodity market, and there are a number of exploration points up there which may possibly go ahead in the future.

Now this leaves the park as a downstream receptor of any possible discharge that could come out of the mines. So what we have agreed to do with the parks is to undertake planning this year, and the objective of that planning is to establish what is the natural water quality that exists right now in Nahanni, and we do not have that. It's a very pristine system as you can see right now.

Now one of the mining communities is CanTung, they're upstream of the mine. They have no positive discharge. They discharge to ground and that is monitored by ground-water wells, and Prairie Creek, which is owned by Procan. They are just looking, trying to come out of bankruptcy and looking at the feasibility of starting up again. They're upstream, so anything that comes out of the mine, if there is anything at all, will go down towards the park. The objective of our work is to (1) characterize the existing baseline; (2) to develop water quality objectives on these streams at the park boundaries, and then (3) we will design an ongoing monitoring program which we will leave with Parks Canada and they will carry that out themselves. So they will have a product in their hands by which to evaluate the ongoing situation in which they find themselves.

Our existing situation operationally right now is very much dependent on one of our brother agencies, which is in the same operation as us, the Water Resources Branch. We're the Water Quality Branch; the Water Resources Branch is right beside us, and they have an existing network around the Northwest Territories of hydrometric gauges. They are constantly going out to these hydrometric gauges around the Northwest Territories. We have taken advantage of that to establish the first level of monitoring. This was established some time ago. When the guys are out in the field, they pick up our water quality information at the same time. That's certainly of value to us and the stations are monitored for a long period of time. It's extremely expensive to do a visit to the Keewatin District, for example, it's ten to fifteen thousand dollars every time they go out.

The limitation in addition to money - we're always using choppers and twin otters, fixed wing aircraft - is space. We can't get the kind of water quality equipment in there that we always like to get in. The other thing is the limits. When these fellows are out in the field, they have their own responsibilities to carry out. They can do some water quality work, but they can't replace water quality professionals, and while they're doing this activity, it's simply not viable to carry out biological monitoring at the same time, for example. So we have some work to do in developing our programs in that direction.



Ambient Water Quality Network, Northwest Territories, 1985.

Now, you noticed at the same time on this map, the gold circles indicate the present location of our fixed network which we operate with the Water Survey right now. The pink circles are stations selected by Indian and Northern Affairs which we pick up free of charge on an informal arrangement with them. I will make one clear distinction, that the water resource manager in the Northwest Territories is DIAND. They are responsible for regulatory monitoring. They are responsible for the issuance of the licence in conjunction with the N.W.T. Water Board, and for the compliance of those licences for industrial discharges.

They also do some baseline monitoring, similar to what we do. So we have a bit of a mandate overlap, which is actually good in some senses. What we're trying to do with that overlap is establish a water quality monitoring memorandum of understanding similar to the water quality monitoring agreements that currently exist down south, or are being negotiated down south. Now these water quality monitoring agreements currently are focussing on three things. They are trying to establish a long-term commitment between Environment Canada and the province to do ambient monitoring so that it doesn't become something that's in one year, out the next year. They're trying to establish minimum levels of quality control to ensure that data are analyzed, looked at hard, and that data come out in terms of state of the environment reports. I think that's a major advance that is slowly taking place across the country right now, and in the Northwest Territories we're also in the process of negotiating an agreement with the Northwest Territories, so the Water Quality Branch, and N.W.T. Programs of the Water Quality Branch are representing Environment Canada.

On the other side of the table, or the same side of the table, depending on the point of view, is Indian and Northern Affairs, and they represent the water managers of the Northwest Territories. In addition to them we have the Government of the Northwest Territories, which is the heir apparent in terms of devolution. It will ultimately receive the water responsibilities, or so it's envisioned right now. We have those three main actors at the table every time we're sitting down. And what we're trying to do is to establish monitoring networks and also get the latest advances in water quality monitoring designed into this agreement or memorandum of understanding necessary to handle the problems facing us right now. One of the advantages clearly is going to be cost efficiency. Instead of having two agencies responsible for ambient monitoring, we've got one agreement working in a cohesive program. If the data-bases are lined up together, that gives them that much more strength.

I think, just to summarize right now quickly, the challenge on us - I know when the Bruntland Report was published last week, I noticed in the time they started to prepare that report until they published it, Bhopal had taken place, the Rhine disaster had taken place, Chernobyl had taken place, the Love Canal had taken place. A number of things had taken place in our environment very rapidly, and I dispute one of the claims made earlier this morning. This water is not getting better. I think we'll have a lot of discussion on that over the course of the week, but we need a monitoring program in place that can absolutely ascertain where we stand with our water resources. Thank you.

P. Whitfield: Our next speaker this afternoon is Gerry Whitley, who is with Northern Affairs Program in Whitehorse, and he is going to talk about the water quality monitoring in the Yukon Territory

G. Whitley: I'm going to pick up where Brian left off. First of all, a pet peeve. The Yukon is in northern Canada, but often when we speak of the North, we really don't refer to the Yukon. I don't have a map here. Yukon's that little patch of ground between the Northwest Territories and Alaska. Invite people to come up sometime and take a look at it.

The Department of Indian Affairs and Northern Development is responsible for water quality management in the Yukon. The Yukon Government is going to take it over in due course, just like in the Northwest Territories, that turnover will take place. Now the Yukon Territory consists of a high plateau surrounded on two sides by mountain ranges. It's fairly nice in the fall like this. We've got the St. Elias and Coast mountains on the west and the Mackenzie Mountains on the east. The mean annual temperature in Whitehorse, as you can see by this sign on the TNM Hotel, is about zero degrees centigrade. As you move north and a bit to the east, it drops off.

Precipitation is about 400 millimetres annually on the plateau. It's quite a bit less in the valley bottoms and quite a bit more in the St. Elias Mountains. About half of it falls as snow and the other half is rain. We're responsible for snowpack measurements among other things, so Eric's out there making sure the snow is still there. Now, in the spring when the water starts to move, we have quite interesting freshets. The rivers open up in early May. This week I should really be back home, it's a hydrologist's heaven. Sort of the old gamble, will Dawson be there next week or not. The ice jam flooding is a major problem on the Yukon River. Most of our peaks are caused by snowmelt, though in the smaller streams intense rainstorm activity can cause peaks. This is an

interesting plume on Lake Labarge where the Takhini River enters the Yukon River and then enters Lake Labarge, and it's just a beauty. You see that on Landsat images too. That's when we're moving lots of sediment out of that system.

This is some ice heading for Alaska. The principal activity of the Water Quality Section is surveillance monitoring. That's where I earn my keep; that's what my boss demands of me. There are over 400 water use licences issued under the Northern Inland Waters Act by the Yukon Board. About 85% of those are for placer miners, and each licencee is required to monitor discharges, and is inspected during the year. We do a better job of getting our inspections done than most of the licence holders do in their monitoring, but we try to get to every one every year.

Of our water users, the first we have are municipal users. We have 24 000 people living in approximately 12 communities. We have sewage lagoons or some form of treatment in virtually every community, and the water in every community is treated and distributed either by truck or by pipe. Only a few areas still have individual wells.

Even a little community like Destruction Bay has a sewage lagoon. We rearranged that a little, I think we've done very well. And even Old Crow, which is our most northerly community here, has a sewage lagoon. We're putting in a new one.

This is often where we do our work. This is one of the technicians filling a sample bottle. This is a start on talking about mining. Our big economic activity in the Yukon is mining. The miners not only use water for processing but they drink it too, and often they forget that and have a little bit of trouble with water quality. In this case, Anvil and their successor Kerr Resources had to put up signs just to make sure their drinking water was protected. This is a picture of the Kerr Resources Cyprus Anvil tailings pond. To give you an idea of scale, many miles away is their freshwater reservoir. This is a small lake. These tails are massive in extent. This is a fairly good sized stream that's been put up on the hillside, and diverted around it. And then the poor technician's down there at one of our surveillance sites filling his sample bottles. We also have some abandoned sites, in this case the Venus Mine. This little tailings pond is loaded with arsenic here, and we try to hit those every year. The bigger mines we do on a quarterly basis or more frequently. Now we're going to look at placer mining just for a minute. A change of pace because most people don't have this

fascinating activity. The miners use ponds to pump their water from. They use water to thaw ground. They use water to move ground. They use water to move muck. This is one of our placer inspectors wondering what he's doing there. These guys, when they get rolling on their cats, they don't stop and chat with you about their licence. You wait till they're finished. You can't get near those machines with your pickup truck.

The water is used to move gravel down though a sluice box, comes out the other end, it's nice and dirty. The gold stays behind, and the placer inspector is down at the end, filling up his bottles. Placer mining is looked upon as a romantic activity, especially by the tourists. They enjoy panning for gold like this old-timer, and it says all that glitters is not gold. This is the reality of it. Very, very large-scale operations. They destroy the valleys, destroy and totally change the streams. Even the thought of rehabilitating a site like this is enough to make your hair curl.

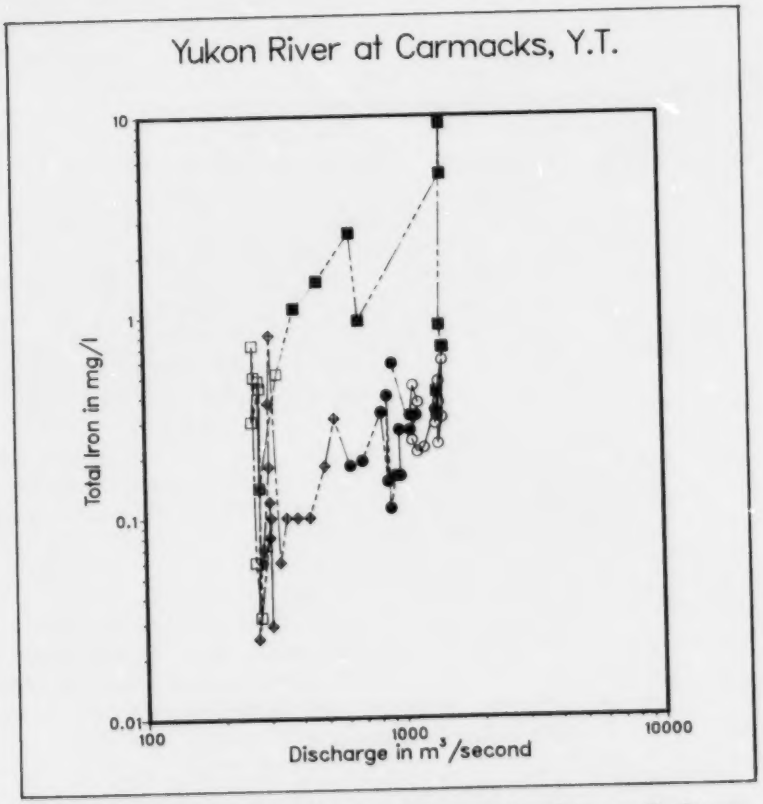
Okay, we do baseline work, primarily we look at sites before mining comes into place. We do upstream samples while they're operating. We're not heavy into baseline work, we're busy enough checking on the current operations. We found real problems with baseline. Out of every fifty operations that look like they're going to go ahead you might get one. The investment gets very, very hard to justify. We get involved a lot in spill response. This is a picture of the Porter Creek sewage lagoon on fire. That's before it really got going. This is a picture of Cyprus Anvil when they lost track of twelve tons of sodium cyanide. The pink colour there is dichromate. That was their first oxidant, but then they went to alkaline chlorination at 30 below for quite a few millions of gallons of water. It was quite a spectacular chemistry test. This is the technician at the time collecting a sample at one of the downstream stations.

Mount Skookum Gold Mines lost track of some oil one day, so there are the technicians looking for oil. We have our fun with those. Some of the sites get abandoned and there are drums lying around. Grizzly bears get into them and other problems, so we deal with those too. A fixed network. We have two stations going in the Yukon right now. This one at Whitehorse running for nearly twelve years I guess now, with weekly data. Plus some daily stuff and other pieces of information. We've got a second station at Carmacks, which we've run for a little more than five years now.

And finally studies. Environment Canada's done a number of studies in the Yukon. We've tried to help out. This is our chairman here with one of his assistants drilling

a hole in the ice, and I think this is the Takhini. It could be the Nordenskiold River. Looking at dissolved oxygen under ice cover. You should take a look at the paper. I've got some copies here if you're interested. That, in the long haul, is going to be important information as we start to dump oxygen-consuming substances into these rivers in the winter. I think we've got our hands full to manage that one. This is out on a field trip. This is our chairman again, right here, protecting himself from the wind. And this is our instream integrated samplers that we use quite a bit. When we get tired filling water bottles, we look for grayling. You can rest assured if the grayling are there, that the system's probably doing all right.

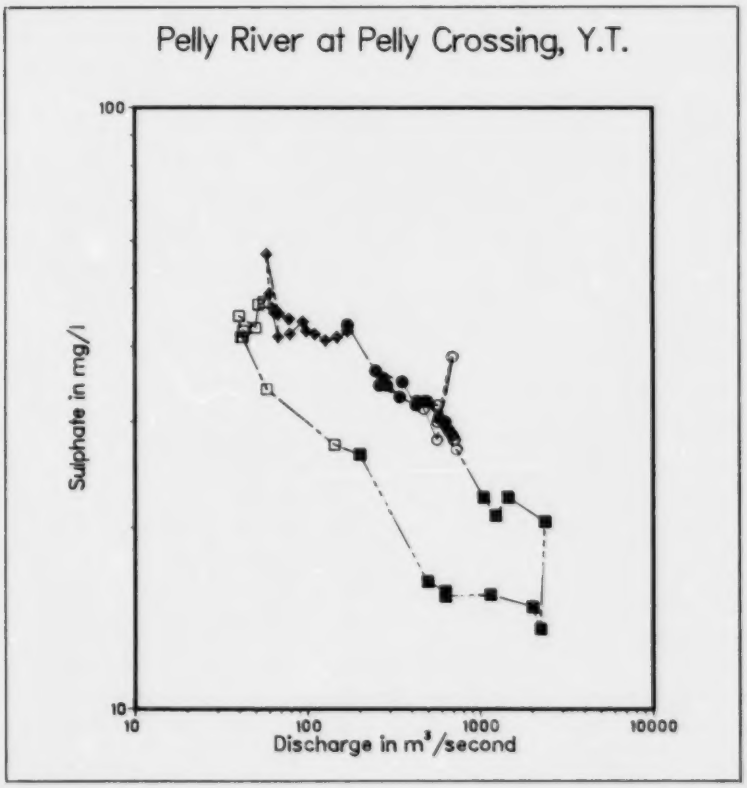
It's a real difficulty running a surveillance network because you feel like a policeman all the time and you know very little about what is actually happening in the systems that you're looking at. So you get a little bit curious and that leads to working with people like Paul, and this is just to show that occasionally a paper gets published. Paul presented this last year in Fairbanks. And just to start off with a few slides from that paper.



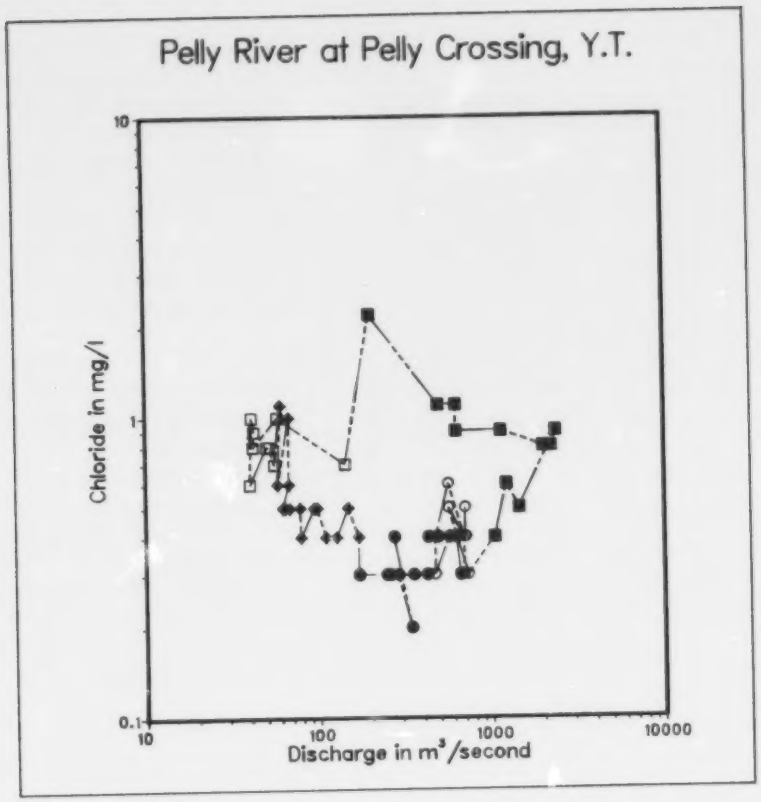
Clockwise hysteresis with a positive relationship to discharge. The symbols indicate; □–March–April, ■–May–June, o –July –August, ●–September–October, ◈–November–February.

This is the Yukon River at Carmacks. It's not too clear. This is total iron concentration here, a log scale. This is discharge on a log scale. What we have here is the suspended sediment in the spring, it goes up with discharge, then we start down, the falling limb, comes back. Traditionally, we take all those numbers and put a line through like this, sort of look at something like this and say, hold it boys, I think we got two lines. That's pretty traditional stuff, but from my point of view it's nice to know.

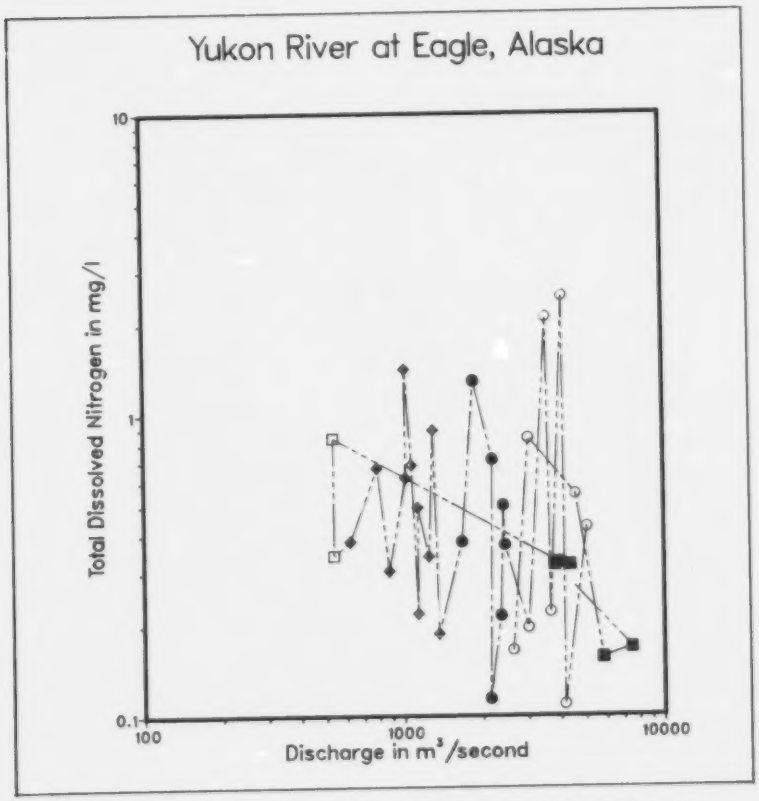
Take another station, the Pelly River, Pelly Crossing. We take sulphate concentration on a log scale, discharge, we've got the traditional relationship of ground-water being diluted with surface water in the spring, like this, comes back when the water level's falling and there's an increased ground-water contribution on a higher side. Again, if we got a straight line here we got at least two of them. Then we take something like chloride. Take a look at it, similar scales, discharge, no relationship to discharge at all. That one I don't understand. I'd like too. If people have some ideas, I'm sure Paul and I would like to talk to them. The big



Counterclockwise hysteresis with a negative relationship to discharge.



A typical pattern for chloride with discharge.



A typical pattern for nitrogen variables with discharge.

system, the Yukon River, is dominated by large headwater lakes, so we look at sulphate near Whitehorse, the outlet of Marsh Lake for one year, and what we have is essentially a straight line, no relationship. If you look at it a bit more closely it has a slight, slight downward trend and is quite similar to the river water. And finally, we have dissolved nitrogen in the Yukon River at Eagle, Alaska, and it's all over the place. Maybe, after a couple beers looking at that, sort of wonder if the system's alive and if we knew where all this material was coming from and which system was showing a productivity burst or something like that and feeding this large station on the Alaska border, maybe we could interpret it. But it's left for the future.

Water in the Yukon is used to produce power. We use it for tourists, which is another way of looking at it. Our wildlife use it. We have moose standing in it and running in it, and we're always looking for bright young intelligent guys, like we have here in the audience today, to come up and give us a hand. If I have a plea for anything at the end of this, it is for the scientist to come up there and explain to us, who have to look after all these development projects, how the processes that are obviously at work there are functioning, so that we can fit our data collection in with the system as it's really performing.

P. Whitfield: Our next speaker is Dave Sutherland from the Environmental Protection Service. Environment Canada has just recently reorganized and what used to be EPS is now just part of Conservation and Protection, so Dave is going to talk to us about their programs in the Northwest Territories.

D. Sutherland: In talking to you about the Environmental Protection Service contributions to monitoring in the Northwest Territories, I'd perhaps like to focus my discussion a little more than the previous speakers, and look at methods, multi-media methods for monitoring, and also look at what various methods have been able to tell us about the effects of past pollution events and throw out a few comments on what that might mean for future monitoring. The mandate of the Environmental Protection Service, as most of you know, in the Northwest Territories is somewhat similar to what it is in the provinces in one aspect and that is we are responsible for Section 33 of the Fisheries Act and the accomplishment of the broad objectives of that section of the Act which are done through negotiation with provincial, in this case, the quasi-provincial, jurisdictions. In this case, of course, with respect to control of freshwater effects, we have the Northwest Territories Water Board and the Department of Indian

Affairs in general who have the jurisdiction of the Northern Inland Waters Act.

The other role that we have Canada-wide is under the Environment Assessment and Review process. Under that process we do have responsibility, that is, Environment Canada in general, for evaluating the effectiveness of monitoring carried out by the government departments and industry. So we're mainly an advice giver, we work co-operatively with other government agencies and with industry in designing monitoring programs, and in order to do that we have had the need to go out and do some monitoring ourselves and to see what methods might be most effective. Because of our predominant role in pollution abatement most of our monitoring, if not all of our monitoring, has been carried out in monitoring point sources related to regulation of these sources. Most of our monitoring also has been done on lakes because most mining in the N.W.T. is in the Precambrian Shield.

You've had a general outline from the Chamber of Mines on the mining activities in the North. Just to recap, we have five operating gold and three base metal mines in the Territories. We also have about ten abandoned mines which have produced tailings at some time since the 1930s. We have one petroleum refinery located at Norman Wells on the Mackenzie River and a certain amount of activity in sporadic bursts of exploration in the Mackenzie and Liard River basins. The kinds of contaminants that are associated with mining include naturally present metals such as arsenic, copper, lead, zinc, cadmium, mercury and uranium series, radioisomers, radium 226, lead 210 and thorium and its radioisomers. We also have cyanide, mercury, zinc and ammonia which are used or produced or have been produced through the mining and milling processes. The kinds of contaminants we encountered with the refinery effluent we have include oil in general, which is in the case of that refinery composed mainly of higher molecular weight hydrocarbons, polynuclear aromatic hydrocarbons, some lighter aromatics and alkanes, and we also have low levels of phenol, sulphides and ammonia.

Now let me discuss a little bit the various types of monitoring and what our involvement has been in using them. First water. Throughout the 1970s, Environmental Protection Service did considerable monitoring at abandoned and existing gold mines, and since this monitoring took place previous to the requirement for much better water quality or effluent quality and before the installation of more effective treatment processes, our water sampling was quite capable of showing measurable levels of things like arsenic, copper, lead, zinc and other metals in the water. Since that time, for

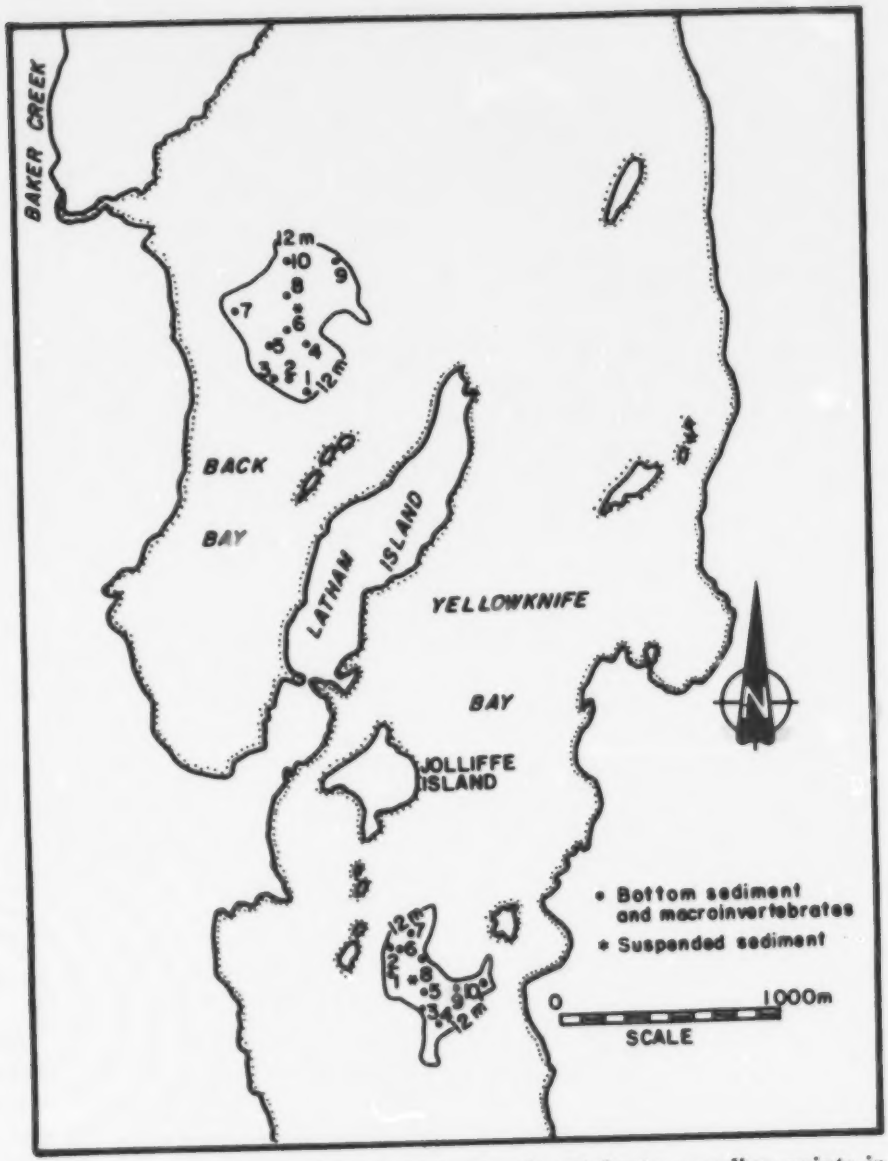
the most part, we've seen effective effluent treatment implemented. We've seen reductions of cyanide, arsenic and some other metal concentrations of up to two orders of magnitude in the effluents themselves. Therefore our emphasis since the late 1970s has been on looking at sediment, because of the nature of these kinds of substances, their life in water for instance, is very short term. They adsorb to the sediment, and what happens there is, I think, the long-term question, as far as impacts, from past and ongoing developments.

Future water quality monitoring in the Territories related to point sources will likely have to focus on improving our capability to quantitatively assess compliance with things like water quality objectives, our guidelines, and it will include testing of new methods for achieving better detection limits and better quality assessment. We're having, I guess, a harder and harder job of monitoring for metals for instance, in the aqueous phase.

I will turn to sediment monitoring. In the 1970s, we also monitored sediment and we used what is called a systematic design in most cases, which was the stationing of sampling points at equidistance on a transect or on grid points, and taking grab samples of the top five centimetres of surface sediment. While these surveys did establish the general relationship between contaminant inputs and sediment contamination, they were not capable of establishing contamination trends, of letting us know what was happening on the bottom, or predict what might happen, and they were also not capable of providing a quantitative baseline for assessing the significance of temporal changes in contaminant concentrations. Because this kind of monitoring didn't take into account sedimentation processes, the effort and resources spent on sampling analysis were large relative to the information gained.

Since that time we've done some work using sediment cores and I'd like to in more detail describe some of that. The sediment coring in depositional areas appears to be the cheapest and most effective way of assessing contamination and contamination trends from longer term mining operations and abandoned mines. The first example I'd like to look at is right here in Yellowknife Bay, where we monitored sediment quality in relation to the operations of the Giant Yellowknife Mine.

This is the general location, and the sites we used for sampling - I should first explain, I guess, the city of Yellowknife is down here on the shores of the bay, extending out on Latham Island. The Giant Mine is located up here, tailings ponds where they deposit their



Locations of bottom sediment and macroinvertebrate sampling points in Back Bay and Yellowknife Bay in 1983 and of suspended sediment sampling points in 1984.

mill wastes are approximately up here, and they now discharge this waste down through Baker Creek into Back Bay. We established two areas, one in Back Bay in the deepest point in the depositional base in Back Bay, and another location farther down Yellowknife Bay. We took two sets of cores, or two sets of cores were taken at these two locations, one by us where we divided the cores into five-centimetre sections, and one by the National Water Research Institute where they divided the cores into one-centimetre sections.

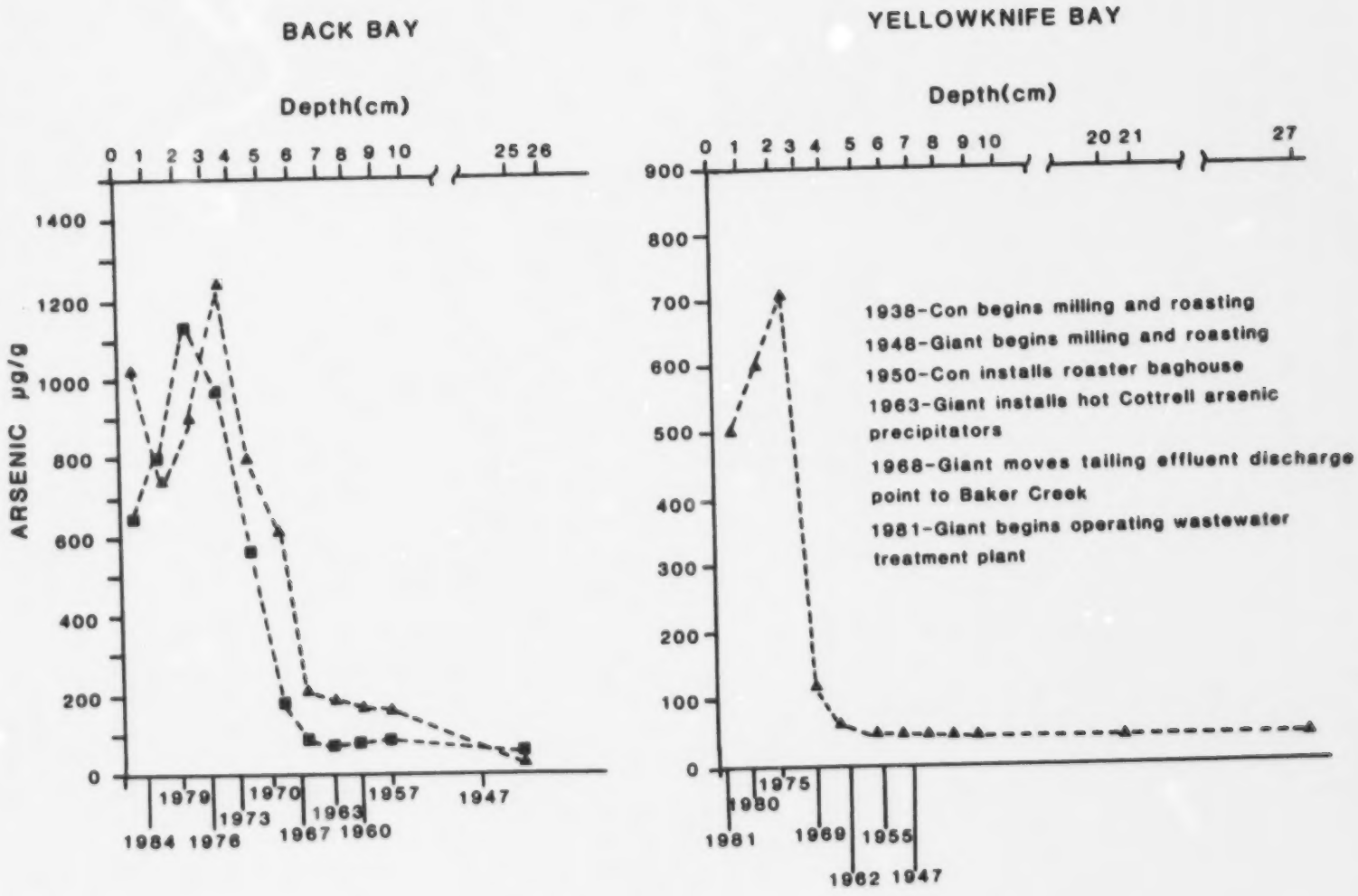
These are the results basically. There are just two points I'd like to make on this diagram. This is arsenic concentrations at the Back Bay and Yellowknife Bay sites that I showed you. The first point is quite an obvious one, and that is the extent of enrichment that has taken place in both these locations from the background level here in the deeper portion of the core to the surface level. The second point is one, more of a technical point on sampling, and that is that using the five-centimetre sections, as you can see here, we lose a lot of information about the input of contaminants and certainly if we were going to use this as a baseline it would probably be a very long time, given the depositional rates in there, when we'd actually see an improvement relative to the improved effluent quality.

Historical Accumulation of Arsenic in Back Bay and Yellowknife Bay Bottom Sediment

Core Increment (cm)		Arsenic Concentration (mean ± S.D. in µg/g, dry weight)			
		Back Bay		Yellowknife Bay	
NWRI	EP	NWRI[a]	EP	NWRI	EP
0-1	0-5	1294 ± 1021	1868 ± 522[b]	453 ± 118	617 ± 31[b]
1-2		893 ± 195		676 ± 154	
2-3		1073 ± 169		420 ± 248	
3-4		933 ± 232		74 ± 24	
4-5		618 ± 130		25 ± 20	
5-6	5-10	264 ± 221	967 ± 725[c]	21 ± 6	227 ± 35[c]
6-7		123 ± 60		20 ± 3	
7-8		116 ± 71		18 ± 5	
8-9		110 ± 58		21 ± 3	
9-10		105 ± 44		24 ± 8	
25-26	15-20	22 ± 3	110 ± 10[c]		85 ± 6[c]
27-28				16 ± 2	

[a] N=4; [b] N=10; [c] N=3

The National Water Research Institute did dating on the cores which enabled us to look at a profile of arsenic inputs relative to waste disposal events. These are data from cores in Back Bay, and we can see there that the large increase in arsenic input into the sediment started

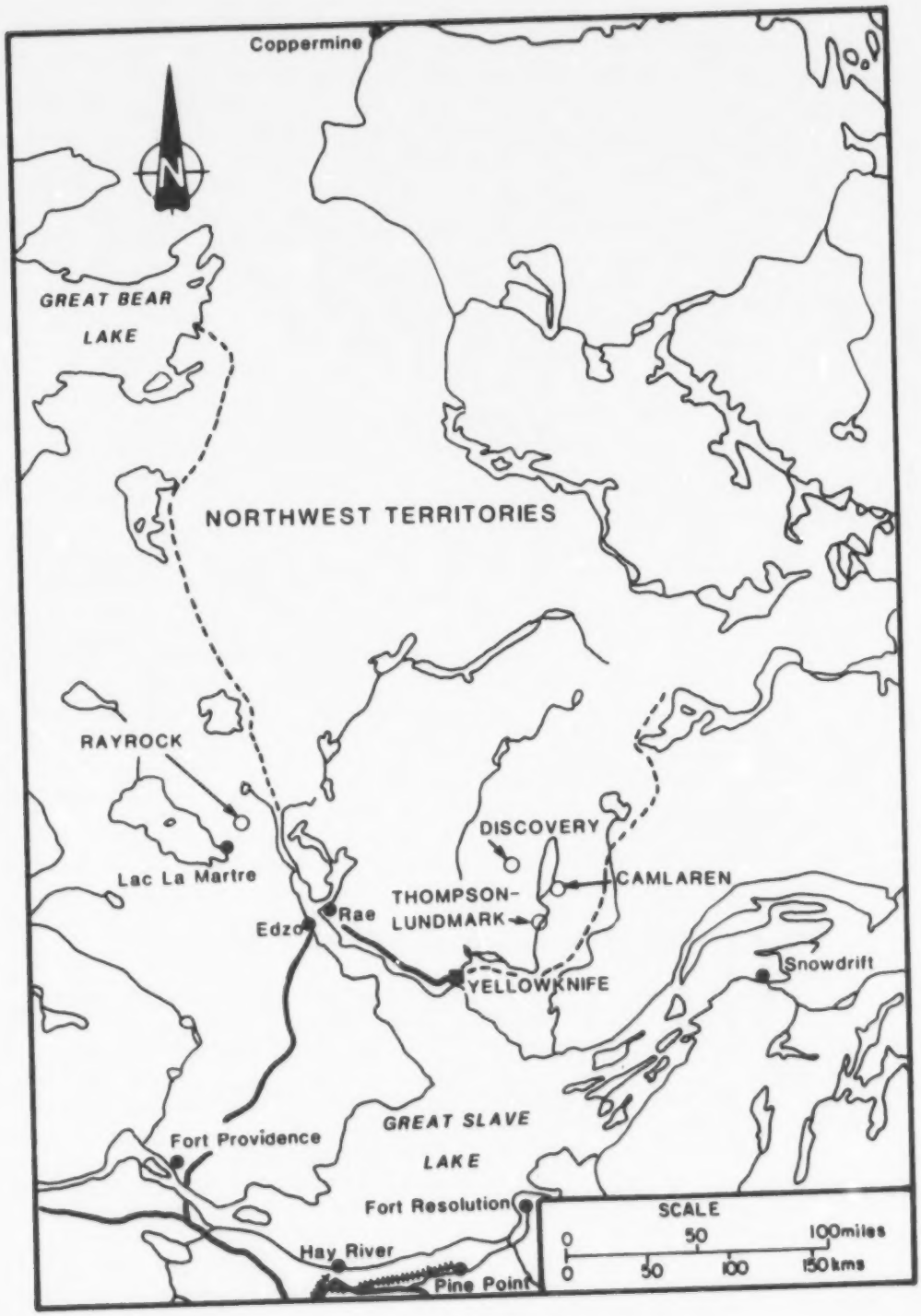


Arsenic profiles in Back Bay and Yellowknife Bay.

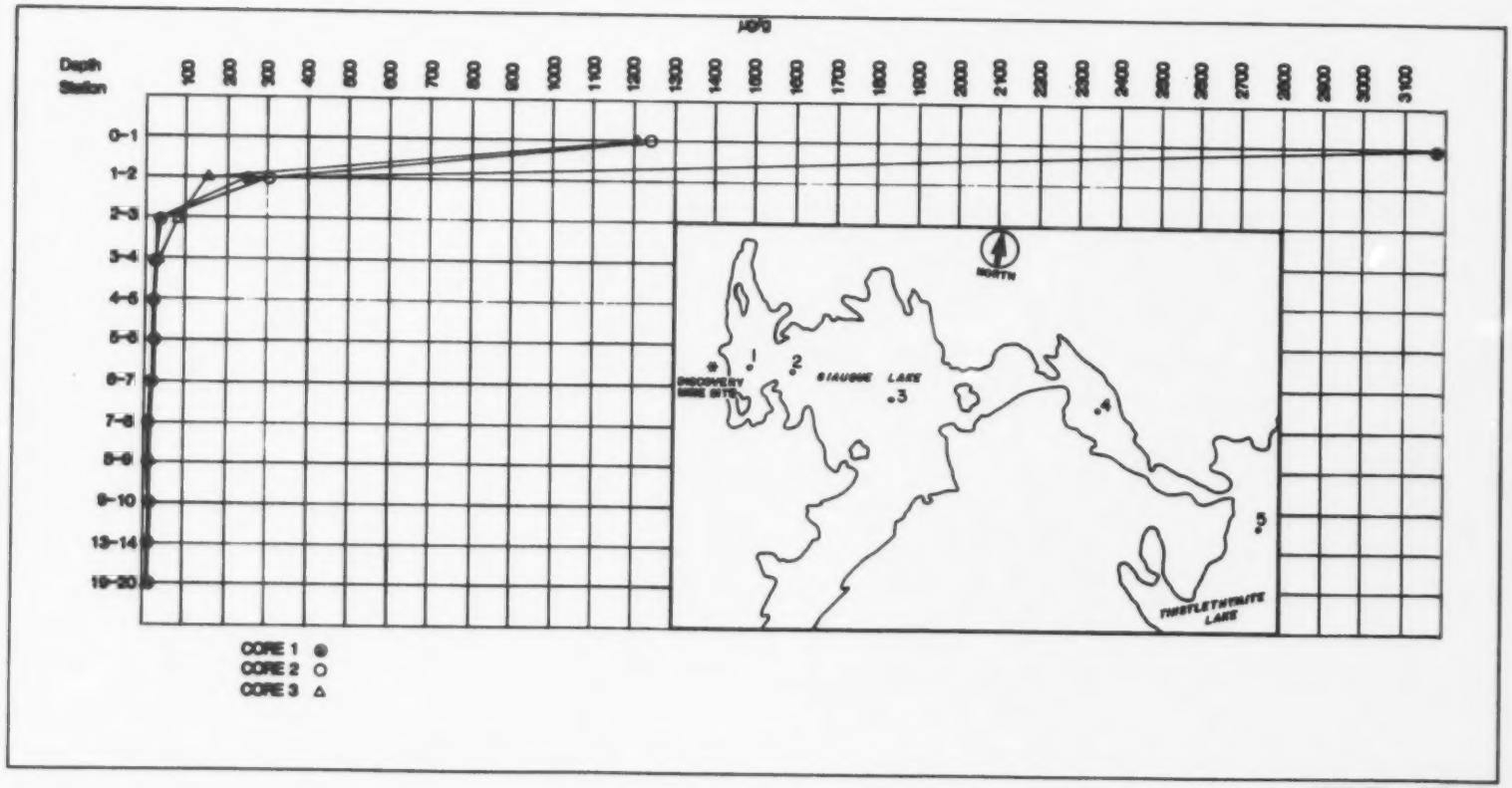
in 1970. From the Yellowknife Bay site we see the same thing, essentially. The substantial input of arsenic occurred at those locations in 1969 to 1970. This date of 1970 corresponds quite well with the change in discharge location that Giant Mine undertook in 1968. They switched their tailings effluent discharge point to Baker Creek which ends up in Back Bay as I showed you, and instead of discharging it north to the head of the Bay, where the river comes in. The other thing that this profile shows us is that clearly in Yellowknife Bay, after about 1980, arsenic levels are starting to drop, which we would expect to see happen, because of the close relationship between the profiles in this area and the discharge of liquid effluent as opposed to other waste sources such as aerial deposition of roaster gases and things like that in the Yellowknife area.

In Back Bay we may also be seeing this peak in arsenic turned around and starting to decrease, although I put two cores on here to show the fact that some of the cores show decreases, some of them show it continuing to increase. I'd also like to show you the use of cores in some of the abandoned mines. This shows the location of the Rayrock and Discovery mines. At the Discovery Mine, although we used water quality monitoring, and I think Don Gamble mentioned this morning, the question of mercury, there was no detection of mercury in there even though we knew it was in the ore and we knew it was in the fish at very high levels - levels up to about 15 parts per million in the fish. This core, I think, shows quite clearly a couple of things. One, of course, very obviously, is that the waste has not stabilized and that mercury is continuing to move in there and go into the sediments even though it's not detectable in the water column. The same pattern at each one of these three coring sites in Giauque Lake shows basically the same thing, that the mercury is continuing to go in and it's continuing to move throughout the lake.

Although we didn't do dating on this, in just looking at a possible range of depositional rates, my tentative conclusion, I think, is that most of this mercury input has occurred since the mine shut down twenty years ago, and the reasons for that are two: one is that there's a fan of tailings in here which continues to erode by wave action, and secondly, the tailings have gone acidic. And the second site I'd like to show you here before I wrap up is the Rayrock minesite. Again, water quality monitoring there has shown very little, or very minor effects on the receiving waters. There are two tailings areas, this one drains into Sherman Lake and down through here into this lake, and this one drains into this lake directly. But this core clearly shows that the wastes there have also not stabilized, and that contamination is

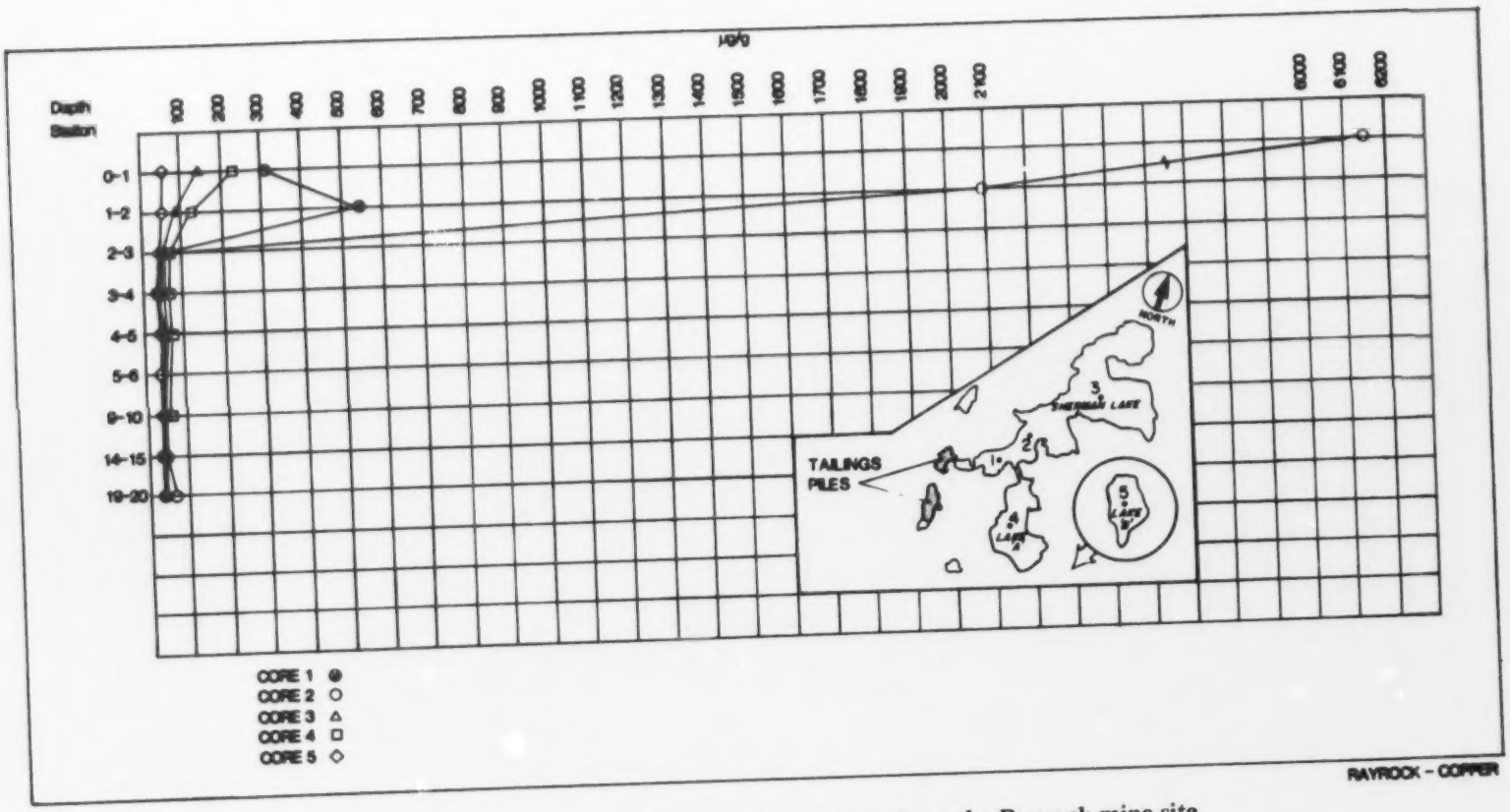


Abandoned mine sites.



DISCOVERY – MERCURY

Profiles of mercury concentrations in sediment cores from the Discovery mine site.



Profiles of copper concentrations in sediment cores from the Rayrock mine site.

increasing. Now, it also shows too that this contamination appears to be limited to that lake at the present time, but the fact that the persistent waste metals and radionuclides in the tailings pond are continuing to move out of there raises a very large question, and that is at what point might they start to move out of that system and down into other systems, or at what point might they start to move back into the water column, or into the fish, such that the use of the lake and the area might be adversely affected.

The last thing I'm going to show for you quickly is the use of monitoring of benthic invertebrates. Again, we have chosen the monitoring of benthic invertebrates as a fairly convenient way of showing ecological effects. These are some values which we took from Yellowknife Bay. You don't have to be that sophisticated to show impacts from the historical depositions of waste. The two areas I showed you earlier on the map, the 12-metre area in Yellowknife Bay and the 12-metre area in Back Bay, which we chose to try and control some of the natural environmental factors that could affect the benthic communities, clearly there has been a very substantial impact on benthic invertebrates. I guess I'll leave it at that.

Comparison of Abundance of Benthic Macroinvertebrates in Back Bay and Yellowknife Bay, August 1983

(mean±standard deviation of organisms per grab sample - 10 replicates per location)

Group	Back Bay	Yellowknife Bay
Amphipods	0.6±0.7	120±45
Chironomids	2.4±1.8	4.6±2.5
Molluscs	0	11.4±7.9
Oligochaetes	0	11.9±6.5
Water Mites	0	0.2±0.4
Total Community	3.1±1.7	148±57

P. Whitfield: The next speaker is Laura Johnston from the National Hydrology Research Institute in Saskatoon, and she's going to tell us about the work that the Institute does, or will do.

L. Johnston: As Paul said, I'm from the National Hydrology Research Institute in Saskatoon, and the Institute is a fairly new institute. I'm here partly to attempt to introduce the Institute, and more importantly to introduce the work that we're doing in the Ground Water Division. The Institute itself is divided into three main research divisions: the Surface Water Research Division, an Aquatic Ecology Division, and the Ground Water Research Division. Now these groups have come from different parts across the country. I'm not sure how many of you are aware that N.H.R.I., National Hydrology Research Institute, has only been in Saskatoon for less than a year. We're still trying to get ourselves organized, reorganized from moving in from various parts of the country, and getting our programs online and operating.

Currently in the three divisions, in the Surface Water Division, there are several projects that are undertaking in the North, but they deal mainly with ice jamming, river break-up and the more physical side of hydrology in the North. Occasionally, they take a Hach Kit out into the field and do some water quality samples while they're doing this more physical side of things. In the Aquatic Ecology Division, it is in the process of reforming. They're also in the process of staffing; they are approximately half-staffed at the moment, so that it will be a while before these programs come into being. I think Rod Allan is going to say something about some of the programs that have been done in the past by this division, and I'd like to concentrate mainly on the Ground Water Research Division.

Partially what we've done in the past, but what's going to be - and are doing at present in the North - that will be dealt with mainly tomorrow by Dwayne McNaughton, and what I'd like to concentrate on today is where we think we are at the moment and where we'd like to go in the future, and I'd certainly like to hear your comments, questions, complaints, based on your perception of what we could and should be doing with ground water in the North.

There are three main projects that we're attempting to start, or are in the process of starting at the moment. One is simply to look at permafrost and ground water, particularly from a water quality side. There is a fair amount of information on the physical properties of ground water and permafrost, but from the literature surveys that we've done since moving to Saskatoon there

does not appear to be a great deal of information on ground water quality in permafrost. As some of the speakers have mentioned earlier today, there's the question of acid rain, toxic rain. We've been involved in these studies before we moved to Saskatoon in a more southerly clime, and we have a fair amount of expertise as to what's involved in looking at acid rain, toxic rain and its effects on the hydrologic cycle.

And thirdly, as was mentioned this morning, we are interested in climate change and its effect in the North. In particular, if the temperature changes by two or three degrees, which most people seem to feel is a reasonable assumption, what will happen to the permafrost, ground-water, surface water system?

Now, with that I'd like to go into more of the rationale of why we think that ground water is an important feature of the hydrologic cycle in northern Canada, southern Canada, wherever one may wish to look at it. There are two main reasons why you have to worry about ground water, no matter where you are. The first one is that you can contaminate the natural ground water source. You can make it undrinkable, unusable, for whatever purpose it may be. I was told this morning that only 1% of the people in the Northwest Territories rely on ground water for domestic supply. So, one might say, well why do you have to worry about ground water quality if there are so few people that are actually using ground water, and it's the second point that is perhaps more important, and that's the influence of ground water on surface water. It can work two ways: if you contaminate the ground water it will eventually, sooner or later, contaminate the connected surface water body. Or, in the case of acid rain, the ground water is working in the opposite way to clean it up. But whichever way the ground-water system moves, or whichever influence it has, we're in the position of saying that today's surface water was yesterday's ground water. And if you don't know what's happening to that particular component of the hydrologic cycle, then you may be in for some nasty surprises. We may all be in for some nasty surprises in the surface water system.

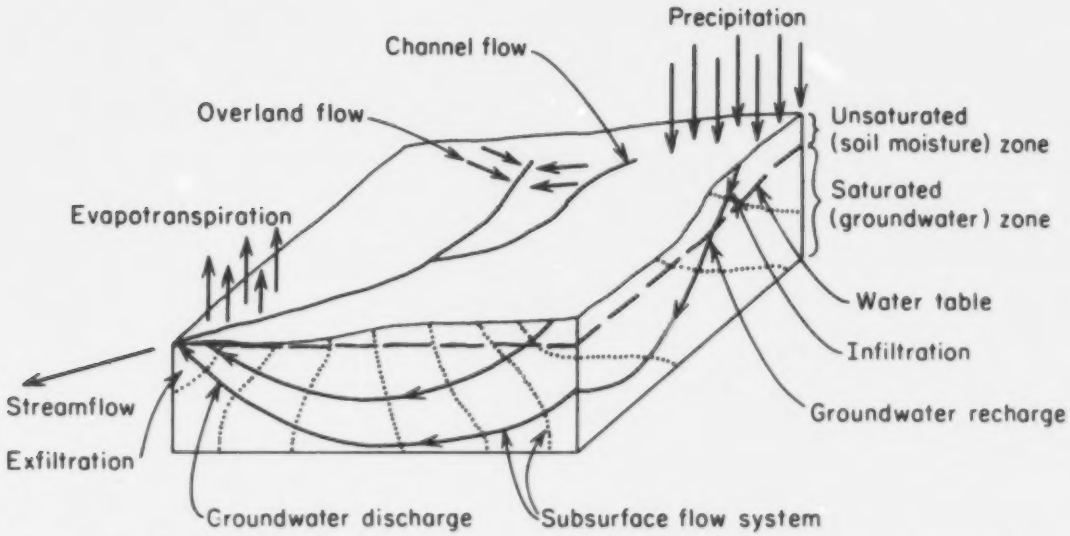
To expand on this a little bit, in a generalized flow system moving from the right to the left it starts with precipitation. In some areas when precipitation falls there's a certain amount that runs off over the surface and into the nearest stream or lake. In many areas, if there's overburden present the ground water doesn't run over the surface, but in fact it follows some path through the centre of the system, through the overburden and as it's moving along the system, its chemistry changes, and that's where the importance of ground water

comes into the hydrologic cycle. So, in general, it's moving from here through the system this way and discharging either to a stream or a lake, and that's where the problems can arise.

Looking at past history, some of the other studies that we've looked at where ground water, in our opinion and, not just our opinion, is becoming one of the most important factors. When the long-range transport of airborne pollutants [LRTAP] program started in southern Canada, in Ontario, Quebec and the U.S., the general and accepted knowledge was that ground water had absolutely nothing to do with it. It was the little black box that made up the hydrologic budget and that was fine, you could just sort of ignore it, and it really didn't have any great influence on what was happening. And now after seven years of research, both in Canada and the U.S., all of the modellers and a good many of the scientists are saying, hey, ground water is the answer. If you have overburden, if you have soils that water can go through and be neutralized before it gets to the surface water, then acid rain is no longer a problem. So it's gone in the space of seven years from being a non-existent part of the black box to an area of intensive research. Both in North America and Europe, saying soil, rock, ground water, that's the answer to the acid rain problem; why some areas that are badly affected and why some aren't.

The same thing with the high-level radioactive waste disposal project. If you put it in the ground and it gets into the ground water, sooner or later it will show up at the surface. I can go on through the rest of these, but - Niagara River is the same; Sarnia. It's the interaction between the ground water and the surface water that causes the problems. That's why, in our opinion, the ground water is an important, if not the most important, factor in what's occurring. I look at all the rock around me and think well, you know, here I am talking about overburden and really how relevant it is, but some of the slides from the earlier presentation, there's certainly a tremendous amount of overburden, and with the ground water problems they have in the Giant Yellowknife Mine, even if there isn't overburden there's still ground water. So it's hard to get away from it, no matter what the circumstances are. They may change, but it's still there.

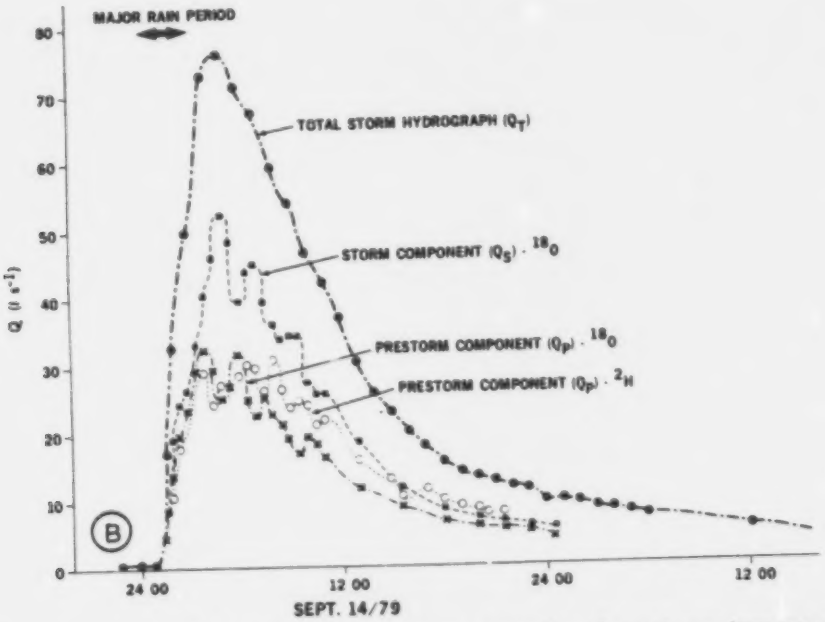
There are two general perceptions, I think, that many people have about ground water. One is that it stays underground, and the other one is that its chemistry is relatively constant. Once it gets underground, it just sort of sits there and has the same chemistry, doesn't move a great deal. I'd like to try and dispel both of those perceptions. The first one, that ground water



Hydrologic cycle with emphasis on ground water (from Freeze, R.A. and J.A. Cherry. 1979. *Groundwater*. Prentice-Hall Inc., Englewood Cliffs, N.J. 07632).

doesn't move. In fact, from this slide, anything that falls in the area to the left hand of the slide eventually works its way through the different overburden systems, through the soil, through the bedrock and comes out in the lake on the right, and that is a space of about a kilometre from left to right. We're reasonably confident that we can trace the water - mind you it takes twenty years to get from left to right, but it gets there, and it happens that at this particular site there's a low-level radioactive waste disposal site in the way, so that it tends to flow along with the ground water at a slower speed than the water, but it's moving, and from starting out in this area, about three years ago it was detected in the wells at that area. So that it's moving. It's slow, but it's moving.

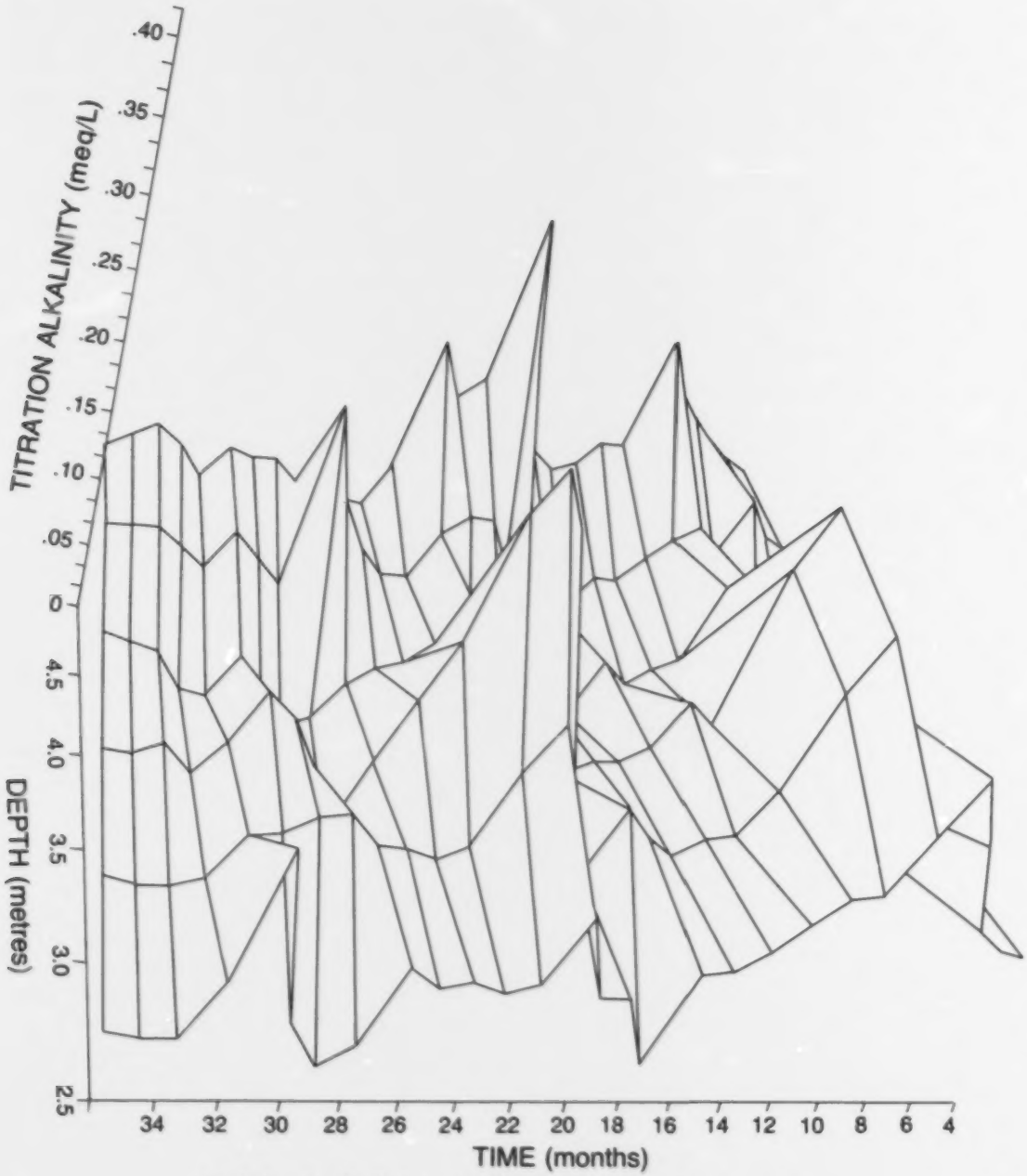
This is a slide of a stream hydrograph separation. I don't want to go into the details, but basically what it's there to show is that once you get down to a stream and you measure the discharge during a flow, which is the top curve on that chart, and try to determine what the percentage of ground water in the stream is relative to the material that's falling on the stream, you find that, depending on the area and the time of the year, anything from 40% to 90% of the water in the stream is ground water, or it has been underground. It may not have been in the saturated zone in a proper ground-water system, but it came through the ground from where it fell to the stream. So that if you're talking 40% to 90% of the water in this stream being ground water, then what happens to it while it's underground becomes important to the water quality of that stream.



Stream hydrograph separation into storm (event) and prestorm (pre-event) components using ^{18}O and ^{2}H.

This is an example of some of the work that we did at the Turkey Lakes Watershed outside Sault Ste. Marie with the acid rain program, and that's only there to show that with depth throughout the basin that we were looking at, those are the changes in alkalinity that occur. We have this for all sorts of different types of chemistry, but it's just to try and illustrate that ground-water chemistry is not constant, and if you want to look at it in a more three-dimensional picture, there's time across the bottom, depth backwards. We have a set of wells that are very close to each other, took samples every month for three years, and the top axis is the alkalinity, and if ground-water chemistry didn't change that would be as flat as a plate. So it's my thesis that, in fact, it does and these are the sort of data that we have. There is a cycle in those data, but it isn't a yearly cycle for some reason. So I hope that these last demonstrations go towards explaining why we think that ground water is important. That it moves; it changes chemistry; and it becomes part of the surface water system that eventually someone is going to have to worry about.

When you're looking at monitoring ground water, there are two - there are problems associated with monitoring no matter what you do. There are probably two that are worse for ground water than for surface water, one of them being cost, and the other one difficulty in obtaining coverage. If you go out on a lake and you



Variation in alkalinity with depth over a 36-month period.

throw your water sampler over the side 30 times, that's an afternoon's to a day's work. But if you want the same kind of coverage for a ground water system, you have to go out and drill your 30 wells before you can take your 30 samples, so that there is a cost factor and a coverage factor. It's very expensive, but the long and the short of this is that because it is so expensive, and because

it's so dispersed, we've really looked at issue-oriented ground-water monitoring. That there has to be a good reason to go out and spend that kind of money, a very specific reason. Most of the provincial ground-water monitoring networks have done the same thing. They weren't established to get a general feel for the chemistry in the area. They were established to look at a specific problem or a specific issue, and define whether it's getting better, worse or indifferent. This tends to be the direction ground-water monitoring has to take, that it be extremely issue-oriented.

Ground water is difficult to clean up. I think that's self-evident. That's why people tend to ignore it. You have two choices. It's cheaper to prevent pollution, or it's even cheaper, probably, to ignore it and hope that we can all retire before it becomes a problem, before it comes out the other end.

Designing a ground-water monitoring program, as I said, is issue-oriented; it's relatively thin coverage, and it's relatively expensive due to the drilling costs that are involved. In designing the programs that we'd like to suggest or talk about for the North, we've looked at the considerations that we haven't had to deal with in the south, such as permafrost, what goes on in the active layer, recharge availability, and there was a comment this morning on climate change which I won't reiterate, but we feel that because of the close nature of the ground-water/surface water system, if the temperature changes just a little bit and the permafrost starts to shift, the whole pattern of drainage is gone.

I'd like to leave you with this, which says "No Fish in Groundwater?" Well, as I explained earlier, many, many streams and a good number of lakes can be anything from zero to 100% ground water, so there most certainly are fish in ground water, and we had better make sure that the quality of that ground water will keep them going.

P. Whitfield: Our next speaker is Rod Allan from the National Water Research Institute [N.W.R.I.] in Burlington, and he's going to talk about various programs that they have undertaken in the North and in another areas.

R. Allan: What I want to mention to you are the past and future projects of N.W.R.I. in the North, and some possible techniques, if I have time, based on some of our experiences in the southern lakes and rivers of Canada. In terms of past projects, as Laura mentioned, our sister organization, the National Hydrology Research Institute, has just been established in Saskatoon. N.W.R.I. is based in the Canada Centre for Inland Waters in Burlington, and has about 500 people. We comprise about

300 of them, and in the past, we had two detachments out West, one in Winnipeg and one in Vancouver, and they did most of the work up in the North. The things we've been involved with, in 1977, 1978, we did a minisurvey of Great Slave Lake and collected some cores from there and looked at arsenic concentrations and came to some conclusions about pollution, possibly from the gold mines in Yellowknife. Between about 1980 and the present, in fact, we had a big study, in the Yukon lakes, headwater lakes, south of Whitehorse, and that is now wound up. It was a basic limnology study, looking at standard chemical, physical limnology of the lakes, and all that's left is to write that up, so we're essentially out of the Yukon lakes.

Between 1983 and 1984 we had projects in Yellowknife Bay and in Back Bay. Dave Sutherland described some of those data to you. I think from about 1985 until the present we were involved in the Mackenzie River, looking at PAHs and alkane distributions down the river, and Brian Olding showed you some of those slides with the boat and the suspended sediments sample. We also had a small project, and I think it was 1983, up at the Polaris Mine, where we were looking at lead pollution of the tailings lake there. That paper just got published in the *Journal of Fisheries and Aquatic Sciences* this year. The Yellowknife paper is released for publication, you can get that one. The paper on the PAHs and alkanes just got finished last week, and the main conclusion there on the Mackenzie, I think, was that the PAHs and the alkanes that were found in the river, most of them appeared to be from sources other than from around Norman Wells. At least at the times that we sampled the river, which, of course, was very rarely.

As for next year and the future, most of the work in the West will be conducted by the National Hydrology Research Institute, but we have a mandate to look at national water quality problems, so we'll be looking at Great Slave Lake next year, taking two or three sets of cores from the lake, and what we're going to do with these cores is radio date them and then analyze them for various things: heavy metals, radionuclides, various pesticides like toxaphene, look for PAHs, look for PCBs. Part of this is to look for atmospheric pollution and to look for what comes down the Slave River. As part of that we'll also have a second, or a third survey down the Mackenzie River that's going to take samples through the ice in, I guess, seven or eight stations; collect suspended sediment and water for looking at metal speciation in suspended sediments, and also to look at PAHs and whatever else we can find in the suspended sediment.

Now, as you can imagine, our big priorities are the Great Lakes, St. Lawrence, the Fraser, places like that, so much of this program is going to be done just when we have time and when we can get round to it. At least once we've got the samples, but I think we'll get a lot of important information, maybe on long-range transport of contaminants coming over the Pole, or down the Slave River, and also in the Mackenzie. So that's the plan for next year, and that's the only thing we've got on the horizon for the North at the moment.

What I thought I'd show you here are just a few of the things, the way we look at it in the Great Lakes and, I guess, this is universal everywhere, in terms of toxic chemicals, metals or radionuclides or whatever else, organic chemicals, the whole idea is to predict models of contaminant fate and effects on natural systems. To do that, there are many ways of looking at it. Looking at polluted sites, and this is the Mackenzie River, Great Slave Lake, whatever; looking at properties of the compounds like the solubility of PCBs or whatever, laboratory tests of various degradation processes of bioaccumulation, plugging this into models, and then seeing if we can figure out what goes on. So a lot of the sampling we do is aimed towards that.

In the Great Lakes, and in a way I look at Great Slave Lake, Great Bear Lake and the Mackenzie River as a sort of opposite of the Great Lakes, where there are the big lakes and the small rivers connecting them, other than the St. Lawrence, and here you've got a couple of huge lakes, but it's the Mackenzie River that's the real connecting, and the Slave. But on the Great Lakes the rivers are just transport corridors. Everything goes straight down them. They tend to be pipelines. There's very little deposition. The smaller lakes in the system, things get into them, get settled out, but quickly get through them and on down the system, and where you see the effects is in the large lakes or out in the estuary. So I think Brian mentioned things down in the Mackenzie estuary and next summer we'll have a look at Great Slave Lake again.

A few gadgets that we've used on the spill in the St. Clair River. We had this mini-camera that we used on the bottom. It's about two or three feet long and a foot and a half wide; can be operated off a small boat, and it came in very handy for looking at the spills that we found in the bottom of the St. Clair River. This is the famous blob on the bottom of the St. Clair River. I know there are spills up here, oil spills. I don't know if anybody up here has got a camera like this, but it's a nice thing to have around when something happens. Another gadget we use, and Bob Platford's up here to show

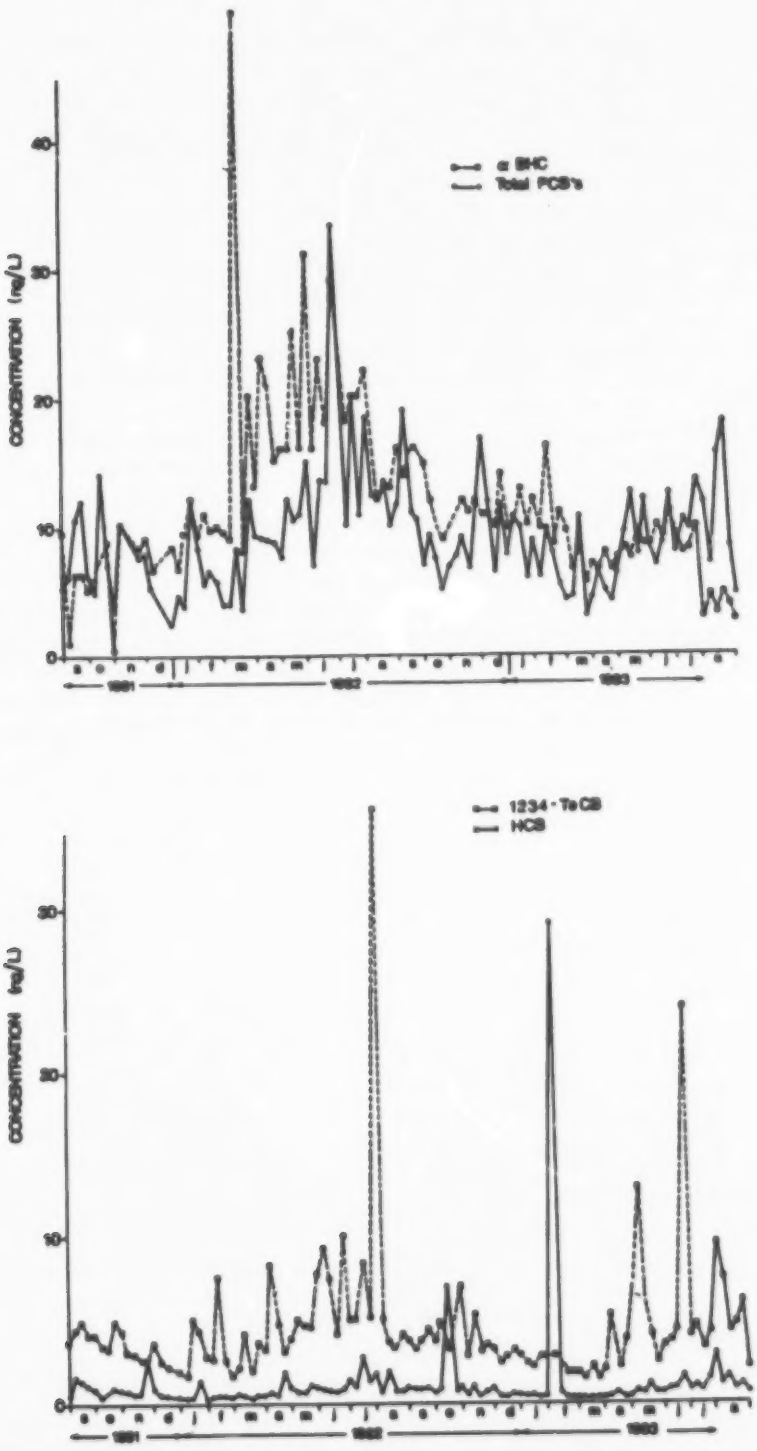
you how you can take it into the field, is one of these APLE [Aqueous Phase Liquid-Liquid Extractor] samplers to get down to low concentrations for organic chemicals. Bob McCrea is sitting in the audience here and I think Bob has done more work with this thing than we have, but it's a very handy device. We've built half a dozen of them now, we use them all over the place, and I think it's something else you sort of need to look at low concentrations of organics and water to get down to the parts per quintillion range.

In the Niagara River you get this kind of pattern. Now this is Barry Oliver's data and you get these giant peaks that occur now and again, even if you sample every week - I mean the flow here is 6000 metres cubed per second, and you get a peak like this, well that really blows all the background stuff out of the water. So you've got to sample very frequently and you have to be sure to hit these peaks. Also, Brian showed you the suspended sediments sampler we use to get suspended sediments to do speciation of metals, and these are data by Ken Lum, and all it's meant to show is that at different times of the summer, you get different proportions of the suspended load, say, for cadmium as bioavailable, and it doesn't do you much good to know the total metal concentration. At least if you do this and you do certain extractions, you're a little further ahead in terms of impact, and that was mentioned this morning.

Readily Available Metals in Suspended Particles from the Niagara River

Sampling date	Cd (μg/g [ppm])	Zn (μg/g [ppm])	Pb (μg/g [ppm])	Cu (μg/g [ppm])	Ni (μg/g [ppm])
82-06-01	2.4	120	(16)	3.6	5.0
	(57)*	(33)	(25)	(7)	(5)
82-06-16	2.2	78	24	3.0	6.1
	(59)	(31)	(17)	(7)	(5)
82-06-22	1.1	46	9	4.0	6.0
	(50)	(22)	(18)	(8)	(10)
82-06-30	1.8	63	18.5	5.5	6.0
	(53)	(27)	(22)	(6)	(9)
82-07-14	2.0	40	8.5	2.0	5.5
	(74)	(21)	(14)	(38)	(6)
82-07-27	3.6	75	15.5	11	11
	(86)	(27)	(15)	(14)	(18)
82-08-09	1.6	3	.16	4.8	9.9
	(71)	(23)	(20)	(8)	(18)

*Amounts in parentheses are concentrations as percentage of total.
Source: K. Lum, National Water Research Institute, Burlington, Ontario, pers. comm., 1983.



Distribution of α-BHC, total PCBs, 1,2,3,4-TeCB and HCB in whole water at Niagara-on-the-Lake (from Oliver, B.G. and K.O. Nicol. 1984. Total Environ., 39: 57–70).

Now these are suspended sediment traps, and at the moment we are trying to talk the Ontario region into putting these into the Great Lakes on a continuous basis to collect suspended sediment. We think it gives a good long-term sampling of what's in the lake and what gets into the bottom, both by productivity in the lake and from suspended sediment coming into it. So you could put things like this out in the middle of Great Slave Lake and leave them out for three months and go back, get one sample and you get a pretty good integrated sample. I don't think we can cart this thing up to Great Slave Lake, but we'll take the cores this summer, probably with a benthic corer. That's if we can get Fisheries to take us out in the boat, and a benthic corer is not the best thing to take samples with. This box corer is what we use in the Great Lakes. This thing is about the size of this podium, about two feet across at the top. But once it goes into the bottom it brings up a chunk of sediment about the size of this table, so you can go in and take half a dozen duplicate cores; you can skim off the surface; you can see all the wormholes. It's really perfect. It's a lot better than dropping a benthic corer and hoping you get something decent. You get much better profiles out of these. This is the same idea for chlorinated benzenes on the Niagara River.

Lastly, this is a thing we've used to look at surface slicks in rivers. It's a little ceramic disk we call a surface slicker licker, and you drive this around on the boat, and you can find some very high concentrations of various compounds, whether they come from the atmosphere or whether they separate out from the water and partition into the surface, we're not exactly sure, but sometimes the concentrations in a surface slick can be a hundred times, thousand times higher than they are in the underlying whole water. And this is just the last thing to sort of put it together. I think from Dave Sutherland's presentation about contaminated lakes and what happens to mercury as it slowly seeps its way into the system, the real concerns we have are with sediment water interactions and chemicals coming back from the sediments as well as just the inflow, but the other big ones, the air/water interactions and of course in the North there seems to be increasing evidence that there is pollution from the atmosphere by pesticides from long-range transport and so on.

Editor's Note: The presentation by K. Thompson was moved from Session 3 to Session 2 at the request of the presenter. Dr. Thompson's presentation can be found in Session 3.

Discussion Period, Session 2

P. Whitfield: I just have a couple of comments I want to pass on. One is the question of logistics and what each of these agencies deals with in collecting data. The logistics of working in the North creates all kinds of problems for implementing programs which can be fairly straightforward in the south. It doesn't matter where you work in the North. Simple things like AC power are hard to come by. The systems that are being looked at in the North often have different phenomenon. Often we get involved with systems that are fairly unique and often the conditions there are extreme, particularly the seasonality. These all confound the problem of gathering adequate data.

One of the big problems that we all face in the North is dealing with aerial coverage, and certainly when you look at Brian's body and try and spread it over one third of the land mass of Canada and ask him to do an adequate job of water quality monitoring, you may be whistling in the wind. Objectives, water quality objectives as a tool, and using them as a tool, I wholly support, I like to be cautious about where you jump in. As a tool they are fine, same comment goes for the ecosystem approach. It's how do you accomplish it. If you set out objectives based on southern data or the scientific literature which deals with a different portion of the world, you could be creating a problem which you don't want to be creating.

One of the biggest limitations that we all face in the North is resource limitations. There is not enough money; there are not enough people to do an adequate job. Most of the agencies that are involved in gathering data in the North have to make some very serious tradeoffs between dealing with the day to day management issues and making decisions, and spending that same money trying to gather the data, and each of them has to deal with that on their own, and each of them has to live with the decisions they make with regard to that.

R. Kwiatkowski: A number of the comments that have been made by the individuals that have spoken today are interesting. There is, I believe, a constant need to get people together to discuss things. In particular, I guess I would like to ask the three individuals who are actually here doing the work, you're constantly having research scientists coming up with incredibly brilliant ideas that they have used on the Great Lakes, southern Ontario or B.C., what have you. Wonderful tools, like guidelines, objectives, standards, biomonitoring. How useful or how often do you get a chance to really use these tools? What mechanism is there available to you to influence this massive group of individuals out there, who are doing all this wonderful science, so that you can say,

this is what I really need to address these problems that I have here in the North? And I don't know if each one of you wants to try and answer that or not.

G. Whitley: I want to start off, because water resources are simultaneously complex and simple. What we're working with here is gravity, water flows downhill. One of the things that's unique about the North is really simple. It's cold in the winter. Our systems are ice-covered. You don't see very many southern research scientists out there at forty below trying to fill a dissolved oxygen bottle. You try it. You haul the little devils out of the water and drop the top into the bottle and it freezes around the seal and the bottle explodes in your hands. And yet my feeling is that we seem to - I have a feeling that I know an awful lot about how my systems function in the summer. I'd love to know a lot more, but I know absolutely nothing about them in the winter. I ask people questions, the visiting scientists don't come by too often, but they do show up, and I ask them well, what about the winter, and frankly nobody knows because we're afraid to go out at forty below in the dark and get out there and start mucking about. But these systems are closed. They're under incredible stress. Water quality objectives are great but even collecting the information that we're talking about, the site specific information at some of these sites, is a logistics problem. Paul said no power. It really gets complicated sometimes. But in general I guess I feel a little bit isolated from the research community. I look forward to opportunities like this to talk to people, and I often would like to take them into the field with us and show them what we like to think is reality. The technicians really need that support to have people out there to see what it's really like.

B. Olding: I kind of agree, I think what you were saying was, do we need the exchange of ideas, and do we need workshops like this, and I think it's one of our major ways - and workshops take various forms. They can be very informal consultations; they can be more formal. We have to have constant communication with the people who are working in the area and not everyone's working in the North. They're working in areas that are close to it. In some cases, in terms of southern information, southern technology has been brought up North. What National Water Research Institute did with us up here on the Mackenzie River has taught us an awful lot, not just about petroleum hydrocarbons in the Mackenzie River but about how to approach large systems. So that interaction has been extremely profitable, and we constantly try to get together with some of the other related researchers. We're quite cognizant of the fact that so much work is done in isolation and we try and fight that, so we will

go and meet with Fisheries and Oceans. We won't just stay with the water people, and we try to get overview definitions of the problems and approaches to those problems. We're constantly doing that.

On the other hand, you're not going to know what's going to work, and to a large extent we're working our way through monitoring right now, to find out what does work up here. We've done some stuff with private consulting agencies where their technology just simply hasn't worked at all. It doesn't work at fifty degrees below zero, simple as that. Other areas, some things have worked. The suspended sampler does work up here, and our job now is to evaluate how useful is that to us. We have to be able to identify the first cut of our problems, and I think that's our responsibility. When we go and start dealing with the researchers. Then they can come in and evaluate how well we identified our problems and add in their perspective and say well, look, you haven't thought about this, why don't you think about that. Then our responsibility picks up again and we have to take that back into the field and start implementing it. I think the biggest problem is the fact that we're fighting against our own bureaucracy as well as the public who perceived our resource as being pristine and not affected. And that has to be dispelled so that we can get on with the work of dealing with some of the problems that are facing us right now.

It's a two-edged thing. Sure, get on with the monitoring right now, but we need that input. Biological monitoring, where do you start on that, up in the Northwest Territories, or the Yukon for that matter. That's not worked out at all right now, as far as I'm concerned. Suspended sediment, we started it. No one else has done it. With NWRI and Inland Waters we've just started doing that and we're starting to evaluate it. Is sediment a transport mechanism of pollutants in the Northwest Territories? LRTAP, everything coming down from the atmosphere, we've got to be in contact with other researchers across Canada, and they have to be plugged into the world or else we don't know what to look for. It's not straightforward at all. It's a very, very complex business and we need the interchange constantly. So, those are some of the ideas I've got on that.

New Speaker: My question is addressed to Dave Sutherland, and that is based on his experience, and unfortunately my question might be a little premature. Maybe I should save it for tomorrow, but I'll ask it today. Based on his experience in assessing the point sources, what advice he could provide us in terms of monitoring the ambient environment. How would you translate the information you've gathered there, into the ambient?

D. Sutherland: Well, I think most of the emphasis has been put into water quality monitoring, but I think I tried to make the point in my talk today that particularly in lake systems, the inputs of wastes such as we see in mining tend to disappear pretty fast from the water column, and go into the sediment. So I guess what I'm saying is that we really need to sit down and rationalize our monitoring approaches. To look at the amount of effort that's spent, and I think we're going to have to, for instance, use the water quality objectives, or establish a water quality objective. To be able to monitor in the ambient environment at a level that will give us time to see a trend before those objectives are exceeded requires a pretty extensive level of effort. It requires a great deal of expense in terms of analytical and sample collection and quality assessment, so that I think that sediment, because it is the other half of the formula if you like, what is in the sediment phase, or another important portion of it. The other phase, of course, is this black box and what happens with persistent materials that are in the sediment in terms of redissolving into the water column or getting into biota, and we really haven't looked specifically at that at all here in the Territories. I can't really comment on what you do beyond sediment quality other than to look at, for instance, benthic habitat and use that perhaps as an indicator of ecological effects.

G. Whitley: I think one point I'd make at the end of this is that we deal with a lot more uncertainty up here. There's uncertainty in any aspect of environmental work, probably in any aspect of human endeavour, and I think in the environmental work that we do in the North, northern Canada, there is a lot more uncertainty in every aspect that we do. We need help on that in terms of consultations with research institutes and with other actors in other areas, but we have to put a lot of effort into resolving that uncertainty. The other thing - it's a lot more expensive to do work up here, because there are no roads, we've got to fly everywhere we go; it's extremely expensive work, which means that we've got to start finding extremely cost efficient mechanisms between the institutions, which is why we try and get agreements between ourselves, and we need some resources to go out there and start doing work that's going to resolve some of these ecosystem approaches, which we do not have right now.

S. Smith: I'm a soil scientist with Agriculture Canada at our land resource research institute operating an office in Whitehorse. I've been struck by the parallels in many ways between what you call water quality and what we call soil quality. We monitor in a way that's not entirely different from the way you folks seem to go about

monitoring water. I did have a few questions, and they relate to this idea that I spoke to Brian about briefly, the State of Environment reports about the quality of water in Canada. A number of speakers mentioned something like things were getting better or up here things are staying the same or they aren't getting worse. Each presentation seems to have discussed a study in which there was a different system of monitoring, monitoring for a different purpose and monitoring different parameters. I just wonder where you're at in terms of a state of environment for water quality when this is the nature of your monitoring programs, and that without a standardized systematic monitoring program, how you can assess this beast we call water quality in a national sense, or in a northern sense. What might be a core set of data that you look at to establish water quality, and whether or not you've thought about indices that you could use to illustrate water quality in the way that we use things like GNP and unemployment rate and rate of inflation to describe our state of our economy. Now there are about six different questions there, but I just wonder, Brian, about state of environment as it applies to water quality and where you are at in terms of getting that whole ball rolling. The reason I ask is we're up against the same wall in soil science in having to describe the quality of our nation's soil resource.

B. Olding: As far as standardized monitoring goes, I think on the plus side of that we are currently conducting negotiations through our Water Quality Agreements, Memorandum of Understanding processes with Indian and Northern Affairs right now, and that will result in a unified database. Some of the parameters will be standardized, some of the QA/QC [Quality Assurance/Quality Control], the quality control will be agreed upon, the data handling, and ultimately we will be getting down to report production on that. That's probably two years down the road from where we are right now. That will be standardized with Indian and Northern Affairs. It will not be standardized across the Northwest Territories; we do not monitor exactly the same thing everywhere because we have to be issue specific, so that means where there's gold mining we're going to be after cyanide and arsenic at the bottom of the basin, and if we're in the Mackenzie River we're going to be doing PAHs and n-alkanes. You're going to have different parameters monitored according to what you're looking at.

We are discussing in the Water Quality Branch right now a minimum standard of parameters, right across the country. That's not in place at the moment right now but we're moving towards that.

As far as indices go, that's a good question. One of the problems we've got on the Slave River is we went and identified all the herbicides, pesticides, the OCs, that were currently being used in the Peace River district in northern Alberta, in the agricultural zone there, and we found out that when we took that list and we had it checked with their own people, and we had it checked with EPS, Environmental Protection Service, that we were only doing 25% of that list at the Slave River, which is receiving the flow from Alberta. We went to our own national labs and said well, can you get us the rest of the list? What about the other 75%? They came back and said, we can boost that to 50%, but only if you can get the money, which we cannot right now. Number two, they said even then the remaining 50% we don't know how to do the analyses for. We could start developing individual analyses for each one of those. Now that's just the surface loadings from Alberta that could possibly be in that system. What about the air transport, what is the priority list there? Do we have the ability for analysis of all of those? No, we don't. We don't even have the priority list right now. That work has still got to be done.

I was down in our research institute in Burlington a few months ago, and posed some of those questions to them, and one of the things they came back with was this concept of toxicity testing, do that instead of going and analyzing for every single parameter. We've already got a hundred parameters identified for Alberta right now and we don't have the money for it. One alternative to that right now is to go into a number of toxicity tests. In other words it's a black box, and if you go and take your samples from the river, you put organisms in them and they don't die - and it's a little more complicated than that but basically that's what it's about - then you come out and say well, we don't know what's in there but it's okay, whatever is in there. Someone will come out and say well, that's a lousy test, you better try another one, and that's what's being proposed, a battery of these tests. Now, that will work out really good if there's no problem, because then we can say fine, we'll drop monitoring here; we'll drop that issue for now; maybe we'll come back in five years or three years, and we'll get on to other areas where we think we do have problems. That way we can save some money.

But the problem is that if we do have an expression of toxicity there, of course then we say, okay, well the black box has now got to be opened up and we're going to have to dive in there. So it is one approach, one technique to start going in that direction. The other one is just straight biological integrators and this is getting into this ecosystem approach, getting away from

just the water column. When we use the word water quality in Environment Canada now, we have a lot of things going on in our head, and it is not just chemical analysis of the water column. We've been discussing this now for years, and when we're thinking about water quality now we mean the aquatic system. Maybe the kind of word we should be using is aquatic system. Perhaps what we have to be doing is instead of monitoring everything in the water column, is go and pick up some fish. If we don't get our hands slapped from DFO, but go in - or else join forces with DFO and go in and start looking at the integrators as another aspect of toxicity testing.

Again, we know that these are areas that need to be developed and need to be delved into; we simply need the resources to be able to do it so we can do our job up here, and I think we recognize some of that.

P. Whitfield: I just would like to comment about indices. One of the problems we have, and we can make a real clear statement between these two gentlemen, is across Canada in water quality the issues are very numerous, and when we sit down with the people from the Yukon and the people from the Northwest Territories, we talk about issues, and in the Northwest Territories we talk about oil and gas, hardrock gold mining. Neither of those is an issue in the Yukon. In the Yukon you got placer mining, hydrodevelopment, hardrock mining, lead zinc mining. How do you develop an index that covers all of that? Because generally an index takes a bunch of numbers and summarizes it down. Does that mean we're going to do everything everywhere? Because we don't have enough money to do some of the things some of the places now, so indices tend to really be a problem.

S. Smith: Yes, I would suggest your indices should be based on a core data set of easily collected parameters. And then the scientific muscle will have to be put to work here to come up with some way of producing a single value from a core data set that, in the way we talk about an unemployment rate, immediately conjures to mind the state of our economy, we need some sort of...

P. Whitfield: Okay, but then one of the responses is, if we could come down to a simple index, you cannot publish a single number for a system because you end up just as they do with unemployment rates, is you have seasonal adjustments, because we have these huge - you saw the stuff Gerry was showing you on seasonality. I mean we have a big seasonal difference in the relationships between the concentration of a variable and its relationship with discharge. I'm afraid that an index will just become totally meaningless, because it

oversimplifies. You're just going to be obscured in noise. I guess the only other thing is you could go to some kind of n-dimensional measure of central tendency which might work, but most people can't handle the concepts. Okay, Rod.

R. Allan: I wasn't going to comment on this but I couldn't sit here much longer and not make it. One of the things that came up earlier was about winter sampling, and I think that's a problem everywhere. We don't have very good data even on the Great Lakes on winter sampling, and I think that's just a general thing. As you know, the samplers don't work, you're trying to take cores out of the Qu'Appelle Lake in the middle of the winter and it's forty below in Saskatchewan as well as forty below up in the Yukon, and the damn corer freezes and you can't get the thing out and you've got to build a hut and get in a $50 000 snowplow to clear a space to get a core, so I think researchers are accustomed to being out in the winter and trying the same things, and we're quite happy to try and do it with Brian next winter down the Mackenzie River, I guess, and do it under ice.

As far as this indexing thing goes and the State of the Environment reports, I think that's a much more complicated thing than trying to get some universal quality index. The real problem is that, and you've heard lots of chemicals mentioned here from organic chemicals and pesticides and metals and nutrients and God knows what all else, that at any specific site there's not much sense in doing six parameters in the St. Lawrence river and saying well, there's no problem with the quality and then doing the same six out in the Fraser River saying the same thing and the same thing in the Mackenzie River, it would just be meaningless. You've got to tailor what you're going to do, depending on what the problem is, and to some extent what Brian says is correct. My philosophy is when you go into a system, you should really look at it first to see what it is you're going to measure and monitor in the first place.

Now I hate to use these tacky terms, but if you do a good GC/MS scan of samples and water and in sediment and identify all the compounds if you can, you can often find that a lot of things that you're not monitoring routinely are the things that may be very important, and those are the things you might then want to go and measure and monitor. Same thing happens with metals. Not only should you look at a whole pile of metals before you decide which ones you're going to look at, you should even look at the speciation of the metals and so on to decide maybe that's what you should do. Once you've got all those things going in a water column, you still don't have a State of the Environment report. Maybe in the

case of metals the dissolved metals are important, and probably a lot of the metal data we've got are not that particularly good because we haven't really been able to measure dissolved forms, so there are analytical problems. Even if you've got all of that, if you tried to write a state of the environment report, say, on the Great Lakes you'd have to involve all of the fish data and you'd have to involve the herring gull data that were mentioned before, the sediment quality data, and a whole pile of other things in terms of the processes that go on in the system to try and explain what the overall state of the environment is. So I don't think it's just as simple as a few parameters.

Also this ecotoxicology thing, I think it's a good idea and another of these terms I'm not too keen on is this battery of tests idea. If you do that and you get some response, that may not necessarily mean that you've got a problem. So, you've still got to go further than that and try and figure out what caused the problem, because the cause of the problem is what you then have to go and regulate and control. So you can start out like that, and then you've got a whole process down the road.

And finally, I think you have to be realistic up here in the North. It does cost an enormous amount to fly in to sites and the logistics are very expensive, and if you look at even the Great Lakes where I think most of the pollution work has been done in Canada, we've had workshops there on things like trying a mass balance in Lake Ontario and we can't do it. We just don't have the data; we have got missing things, nobody has thought it through far enough to see what you need to do this, and if you could do it, it would cost an enormous amount of money. So up in the North, my feeling, and this is what I tried to get over in my presentation, is if you can do one or two or three things at least for the research community, we try and focus on things, and we've been involved in the hydro developments up in the Yukon, which was mentioned as a major thing, there has been some involvement in the placer thing; we're interested in this atmospheric deposition business with Brian, and we're interested in things like the PAHs in the Mackenzie River. So I think you kind of have to target what you want to work on and put your limited resources there and do it.

P. Whitfield: Really, in British Columbia we're just getting started on objectives. We've been at it now for three years, and we've made most progress on the Flathead River, and on the Flathead we've, in addition to the work that we've been doing with the International Joint Commission, we've been developing A-base objectives as well, and we're currently at the stage where we have proposed site

specific objectives on the Flathead. On the Similkameen we've probably made the second most progress, and we hope to have objectives in place in some form on the Similkameen in the next year or two. On the Columbia we've made almost no progress, and the Fraser River, we're currently collecting scientific information and data that will support development of objectives in we hope the not too distant future.

L. Noton: What I wanted to bring out was in the past there have been some province-wide water quality objectives by various jurisdictions, Alberta for example, and they were done fairly quickly and now we're into a different order of magnitude of work on the same question, and I think it's a lot more painful and drawn out and much more lengthy process. For example, the only river in Alberta that's really been tackled is the Athabasca, and they've had a water quality planning committee on that one for about three years and there are probably another three years of work ahead of them on it, at least with the present level of priority it's getting.

D. Sutherland: In response to your question I'd say that no, we really do not have sufficient information to say that there's cause and effect. There's obviously a good correlation, even just using those two areas, but I think we have to remember that we're dealing with a whole soup of different substances going in there, so if for instance we set a criterion for 200% reduction in some benthic indicator, whether it be community composition, species composition of community or population, we don't know enough to be able to say if we see that criterion triggered what can we do with the effluent, other than to reduce everything as much as possible according to economic restraints, technological restraints, and then monitor the response to it.

I think in the context of Back Bay, for instance, using that as an example, I would be very interested in looking at some of the other areas in the Bay which have received wastes. For instance, as I mentioned, the Giant Mine used to discharge their effluent to the north end, or to the head of the Bay, and somewhere in there, there's a depositional area that contains some of that material. It may be, would probably be more deeply buried now, as a result of shutting off the effluent. I think it would give us a good indication of, for instance, how deep a layer of sediment might cause what level of recovery in the benthic populations, but we're still dealing with a pretty complex mess in that black box.

End of Session 2

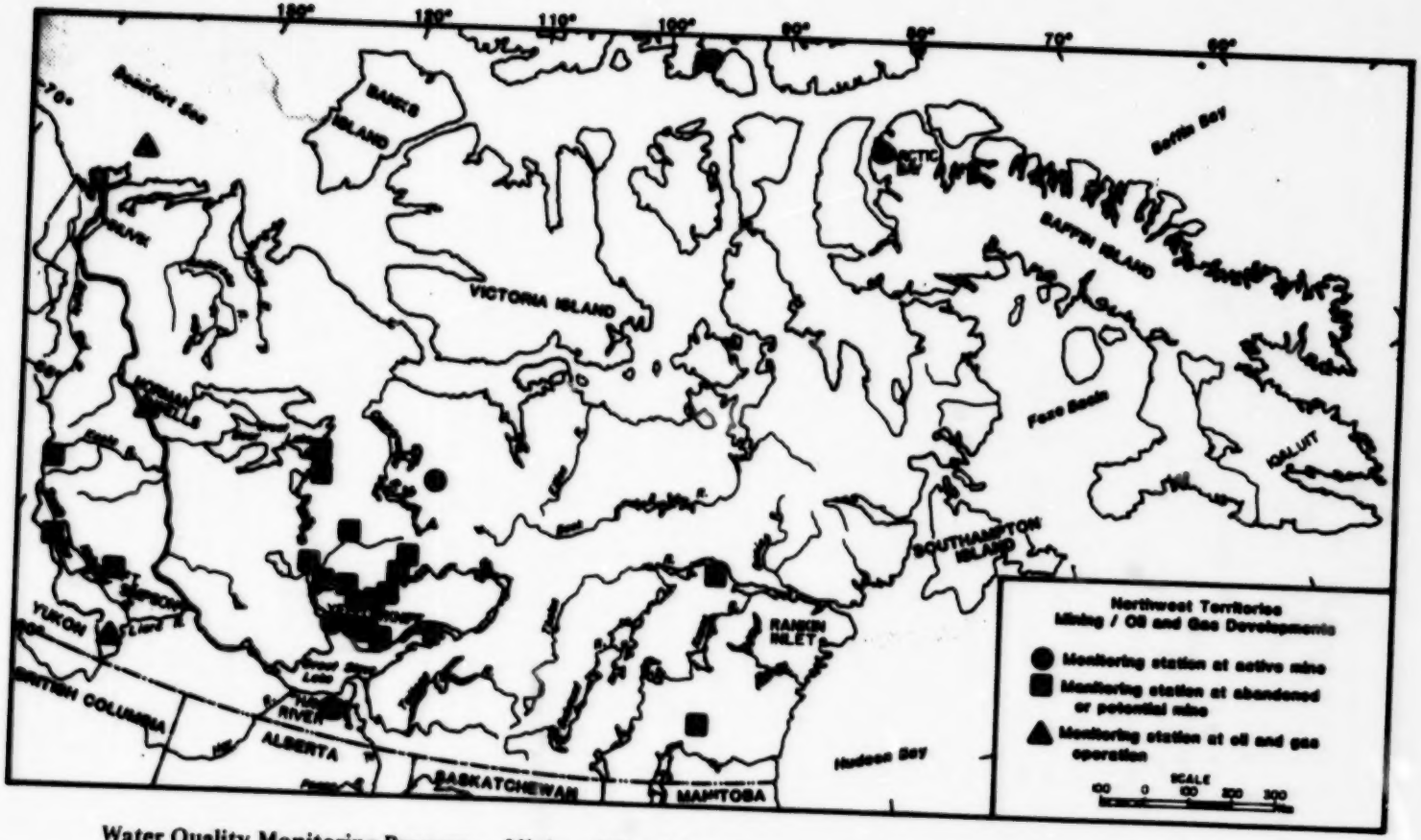
D. Stendahl: Indian and Northern Affairs Canada has a very broad responsibility in the Northwest Territories. It has the responsibility to manage the water resources. It derives this authority through the Northern Inland Waters Act and Arctic Waters Pollution Prevention Act, and this responsibility is somewhat similar to what is done by provincial environment ministries in southern Canada.

Essentially, what goes on in the North is a permit system utilizing the N.W.T. Water Board, and through this system water licences are issued, which enable control of water use and waste disposal. Once these water licences are issued, the administration and enforcement of the licences become the responsibility of our department, and district staff are involved with this as well as our regional headquarters people. The district staff essentially do inspections and sampling required for water quality programs that we undertake.

To manage the water resources of the Northwest Territories, there are a number of issues which we must address in order to protect those waters, and I'd like to go through those now with you.

Mining and milling exists and poses a threat to the waters of the Northwest Territories. There are nine active mines in the North at present. There are four recently closed mines and a few abandoned mines which require monitoring. Although there are many areas in the North that pose potential mining developments, very few of these ever get on stream. It poses a difficulty for us though in selecting which ones to monitor. In fact, there are 30 000 mining claims and leases within the North.

This map illustrates the mines that exist in the Northwest Territories and as well the oil and gas activities, which are fairly well established. Each of these are the significant ones which I mentioned and I have not indicated areas where there is mining exploration or mineral exploration, which is at a very low level of intensity at present. I am sure you recognize some of them on the North. There's the Polaris Mine, the Nanisivik Mines, the Yellowknife area, the Baffin area. Within the Baffin Island area there are the Nanisivik Mine and Polaris Mine. There's the Lupin Mine north of Yellowknife, and a large number of mines in the vicinity of Yellowknife. The Nerco Mine, Pamour Mine, Treminco Mine. As well there are potential mines at Russell Lake near Rae-Edzo and also the Neptune Resources Mine which may go in at Baton Lake north of Yellowknife. There's also the old Discovery Mine north of Yellowknife which requires monitoring.



Water Quality Monitoring Program – Mining, Oil and Gas Developments, Indian and Northern Affairs Canada.

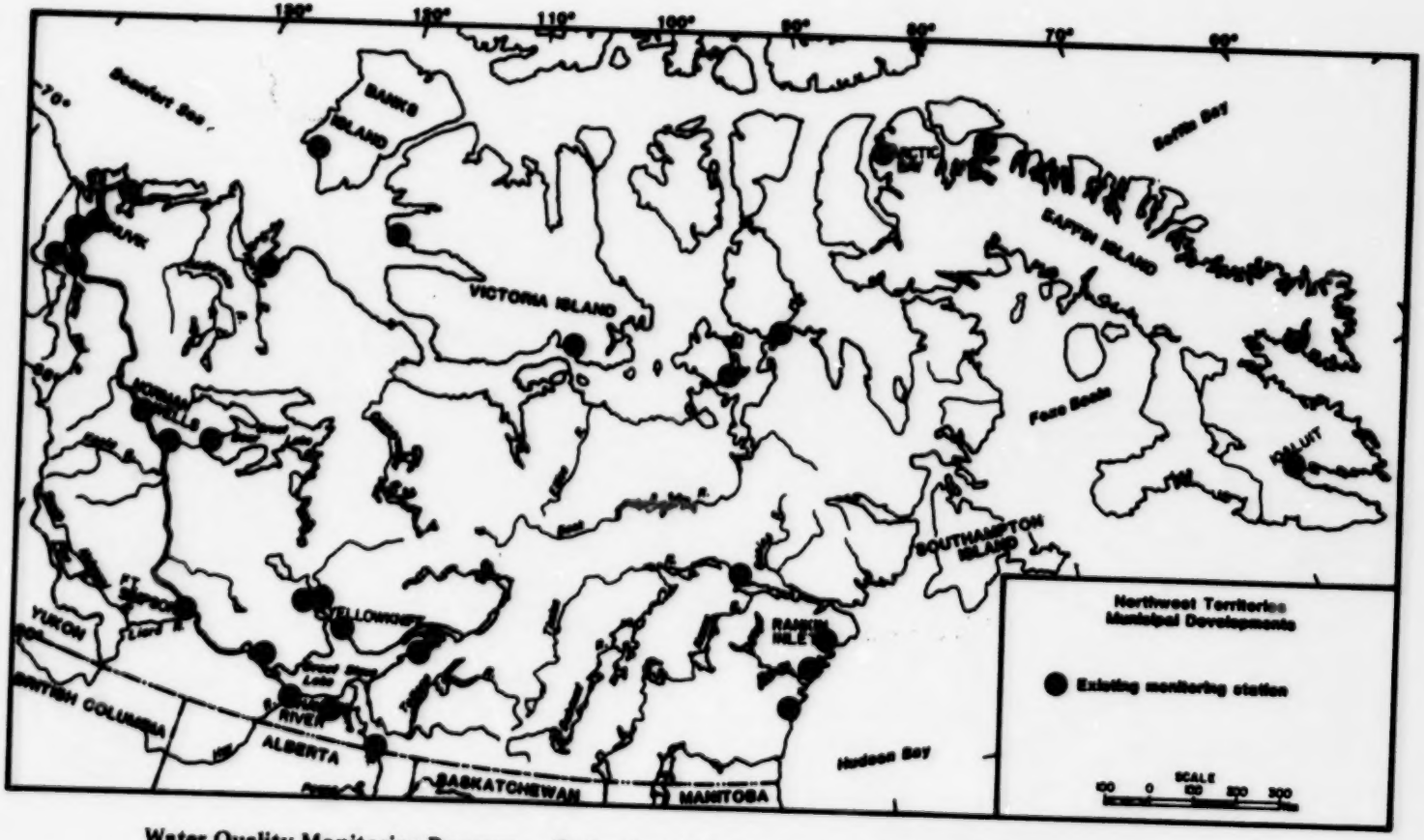
In the Keewatin there is the uranium mining, mineral exploration that occurs near Baker Lake. There is also the abandoned or recently closed mine at the Cullaton Lake area. South of Great Slave Lake there's Pine Point Mine and over in the Mackenzie Mountains there's Cantung, a recently closed mine. There's Cadillac, a potential lead/zinc/silver mine. And Amax, another potential tungsten mine. On the Mackenzie there's the oil and gas production at Norman Wells, and as well, related to oil and gas sector, there is the potential oil production in the Beaufort Sea at the Amauligak structure which Gulf has just been working on.

Regarding municipalities, there's also a need to do some monitoring for those as well. There are over 60 municipalities in the North. Some of these do not require us to do any monitoring because they are very small communities and generally discharge to privies. Colville Lake would be an example. Others though have a much larger population size and they have sewage lagoons which directly discharge to receiving waters, and some of these could possibly pose problems because downstream there are Indian villages or people drawing water and there's a need to have good quality water being released from these lagoons.

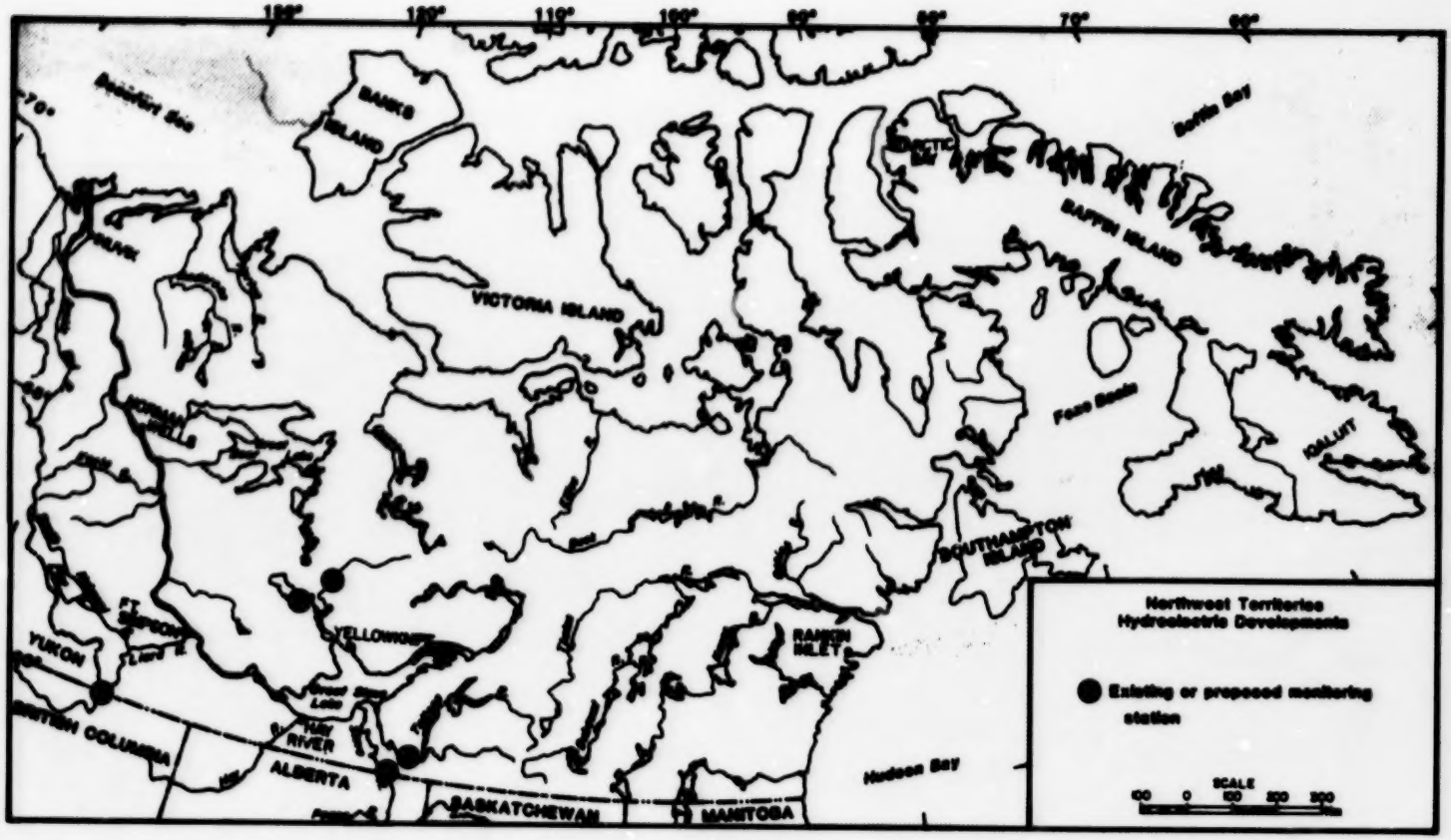
For hydroelectric water use, there are two active hydro plants within the North, one on the Taltson River and one on the Slave River. This is the hydro plant on the Taltson, and on the Slave, north of Yellowknife. For hydroelectric, I've also indicated some other issues here on this map, as well as the two which I already identified. There is potential hydro development both on the Slave River and Liard River. Also, there is potential hydro development at Lac la Martre because of expansion of the Yellowknife base and there may be a power demand, an increased power demand, beyond what the Snare River can provide.

Regarding toxic chemical spills, there are approximately 150 of these each year, one third to one half of these have to be responded to by our department because they arise at mines or the oil refinery or on winter roads.

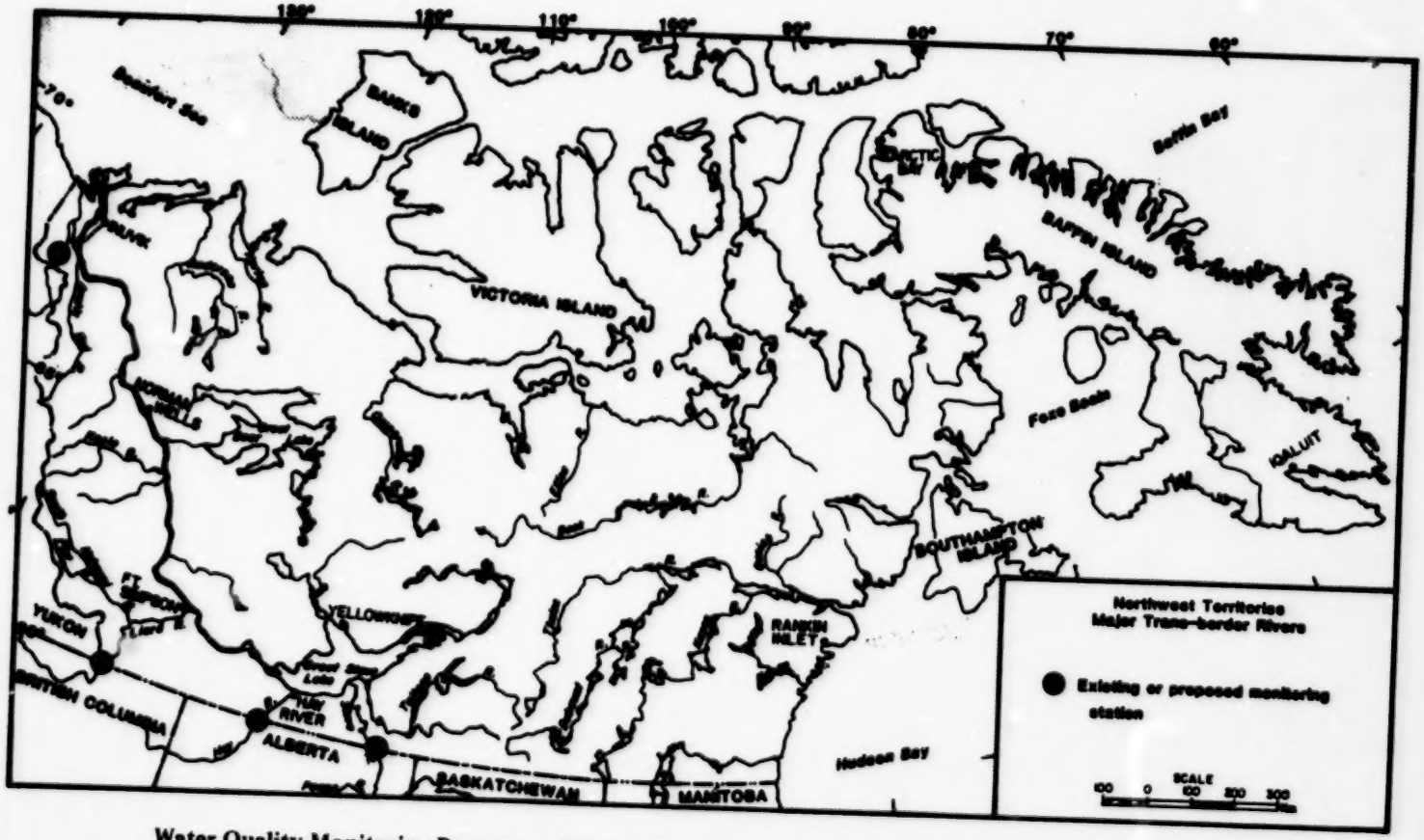
Transboundary water management has become an issue which requires monitoring by our department. We do manage the transboundary waters, and the Northwest Territories has significant water bodies which feed water from southern Canada to the North through the Slave River, the Liard River and the Hay River, and others which are quite important. This is the Slave River right here at Fort Smith, which is fed by the Athabasca River system and the Peace River system in Alberta and other provinces. I've marked the most significant transboundary crossings on



Water Quality Monitoring Program – Hydroelectric Developments, Indian and Northern Affairs Canada.



Water Quality Monitoring Program – Trans-Border Rivers, Indian and Northern Affairs Canada.



Water Quality Monitoring Program – Municipal Developments, Indian and Northern Affairs Canada.

this map. There are eight marked along the Alberta-N.W.T. border, and those are indicated because we're presently discussing developing monitoring programs for those. There's also the Liard River one which is marked and the Peel River one in the north which is on the boundary between the Yukon and N.W.T.

If you put all of these issues on a map, you get a better idea of the intensity of development which exists in the North. In essence, really, there is not a large amount of development in the North. Most of the development exists within the Great Slave Lake water management area and along the Mackenzie River. We are basically dealing with point source discharge problems in the North. We do not have non-point source problems that arise from agriculture, say, as in southern Canada. That is one problem we do not have. As well, there's very little multiple development and conflict of water use, and also there are no problems or very few problems with water supply within the North.

The conclusion that you reach from this is that you should essentially be managing the water resources of the North through regulating or controlling the discharge right from point sources. However, you have to recognize that there's a vast area to be monitored, and as a result of that, it's quite costly to undertake monitoring, and so you have to assess your priorities and decide what needs to be done and then carry that out and other things may have to be left. It's just another problem with dealing with the North, it's such a vast area, it's hard to be able to demonstrate to the public that there's adequate water quality everywhere, when you cannot be monitoring at all points.

Indian and Northern Affairs Canada essentially maintains three monitoring programs, or types of monitoring programs which we incorporate. What we call baseline monitoring, compliance monitoring and effects monitoring. With baseline monitoring essentially what we're doing there is monitoring the predevelopment condition. This information is then used and applied to develop effluent quality requirements for licences. As well, baseline monitoring is also used to monitor trans-border rivers and the issues across them, and as well baseline monitoring is used as the database on which to look for effects or impacts later when a development arises. Compliance monitoring is the monitoring essentially of waste discharges and spilled materials and any unauthorized discharge of waste in the North. Effects monitoring is monitoring of impacts of waste discharge.

The monitoring programs that we carry out for these are essentially of two types. For special problems we will

go in and do short-term intensive sampling and the sampling done for that would be specific, depending on the problem. We also maintain fixed station networks in the North, generally to deal with compliance and some to deal with baseline monitoring. The bulk of the monitoring that's been done to date by our department has been related to compliance monitoring. When the Northern Inland Waters Act was proclaimed in 1970, it took two years before an office was established in the North and from that licences were then prepared for the N.W.T. Water Board. It took us till 1977 to have all of the industries which existed at the time the Northern Inland Waters Act was proclaimed to have licences prepared for them and compliance monitoring or surveillance network programs established. It was in 1977 as well when the first municipality was issued a water licence. So most of our focus has been on compliance monitoring. We've needed that information to develop water licences.

In the latter part of the 1970s and early part of the 1980s, there has been a shift to a degree, and we have spent more time in tightening the requirements within the licences. At first, the licences were developed largely documenting what was the existing waste discharge from a facility. Improvements were then made through time, recognizing that developments and improvements in treatment technology would enable better waste management and better environmental protection, and as we went through time utilizing largely effects monitoring results from other agencies such as EPS, we were able to establish and identify where the problems existed and there were more stringent waste water requirements applied to those licences. But again, it was largely in the immediate vicinity of waste discharge points and compliance monitoring.

We have begun to enter a new phase where we're utilizing baseline and effects monitoring more in our programs. Baseline monitoring has become very important, since we now incorporate the results from baseline monitoring in development of the effluent quality requirements of the licences. Essentially, two processes are followed. One is an examination of the treatment capabilities for that particular activity. The second is the environmental protection assessment, and in that one we essentially look at the available dilution or the dilution that's available to protect the water body of interest at that site, apply that with our knowledge of baseline water quality in that water body, and the surrounding water bodies, and also utilize national guidelines or whatever water quality objectives we find are appropriate for that site, and then determine a licence requirement. That's the basic approach which we utilize right now.

Baseline monitoring is also important from another point of view and that is the trans-boundary issues which exist. Trans-boundary issues have become quite a focus for our department over the last two years and we are having to develop programs for quite a number of the large rivers which enter the Northwest Territories. Effects monitoring is also an important part of our program and becoming more so. It appears that every time we issue a licence and we go through the process of applying these water quality objectives, it always seems to be questioned whether those water quality objectives which are basically a national standard or one that's taken from some other jurisdiction, they seem to be questioned as to whether they will provide suitable protection of the aquatic resource in the Northwest Territories. So the only way to deal with this is to directly assess impacts from our waste discharges on the surrounding aquatic biota, and so we are now undertaking effects monitoring and supporting those done by other agencies such as was done, and probably described by EPS at Norman Wells, and there are others.

We believe that over the long term, our emphasis on the baseline monitoring and on effects monitoring will improve our ability to protect the waters in the Northwest Territories. It will also eliminate the reactionary approach that has been taken somewhat in the past to new developments and enable us to plan water resource development. This will help preserve a resource which we all appreciate. Thank you very much.

R. Allan: What I'd like to ask is, given that this seems to be very comprehensive and requires you to go to all of these places to set licences and do all of these things, can you tell me what sort of resources we are talking about here? Is this you and two technicians or we are talking about a big organization of people, and how many samples do you collect, how many sites do you go to and how involved are you with the federal government in doing this?

D. Stendahl: No, I don't do it myself and I would never claim that. There are approximately 65 sites. That map that I showed you of issues previously, the one that integrated all of the issues. Nearly all of those sites are sites where we undertake monitoring of waste discharges, so that is our compliance monitoring program. At many of those as well, within the vicinity of that waste discharge, we do an effects monitoring program within an initial mixing zone and that is used to develop our effluent quality requirements. That is essentially limited to physical chemical measurements and not biological monitoring, and that is what we're looking to do more of through case studies.

There are district offices within the North. I believe there are six of them, Fort Smith, Yellowknife, Baffin, the Keewatin, Fort Simpson, Inuvik, and it's staff within those offices that do the sampling. They are essentially our DIAND inspectors and work under the Act. The costs for the program, it's difficult for me to give you a number right now, I can give you an example right now. We presently have an effects monitoring program being done within Yellowknife Back Bay area, right near the city here, and that program is costing us $100 000 to undertake and for that program we are utilizing consultants. As well, though we utilize support from other government agencies and through the Northern Oil and Gas Program and others, e have enabled EPS and Inland Waters Directorate to undertake programs. No, we don't do it alone. We try to work with our other agencies and we couldn't do it at all without our district staff.

S. Smith: Within your baseline monitoring program, how do you select which parameters to analyze for?

D. Stendahl: If you're talking about a predevelopment scenario where all we would know is that Comaplex Developments or whoever is looking for gold in a certain area, we would presume that because it's hardrock mining and that it is in the Northwest Territories, they would be using some sort of cyanidation process, and so we would probably undertake some baseline monitoring for the minerals found within that mineral zone. The descriptions they provide based on their diamond drilling give us what we want to know on the background arsenic levels within that potential development area. As well, once they've established where they're going to deposit their waste or whatever - and this is all taking years and years, it just doesn't happen overnight - we have more information and we're able to then map out the discharge course and that baseline program becomes refined through time.

S. Smith: So the baseline, the parameters that you would analyze for in a baseline program are dependent on the anticipated activity?

D. Stendahl: Yes, that's right.

S. Smith: And presumably, then, for each different activity you would analyze for different parameters.

D. Stendahl: To a degree, yes. Because there are generally no water quality data for the new areas, the new developments, we're generally just going in to find out the hardness of the water; what sort of protection is there for aquatic life; answer some basic questions; find out what the major ion levels are, etc. But very often for mining in

general we have a suite of nine parameters which are essentially the ones of most environmental concern, and those are the ones we would analyze there. That would become more refined, as we know what type of mineral they would then be extracting and what they would be adding through a milling process or whatever.

Session 3
General

Session Chairperson: Dr. Hague Vaughan

Terrain Geochemistry Surveys, Permafrost Studies, and Arctic Limnology, District of Keewatin, N.W.T.: Implications for Water Quality Monitoring in the North

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Owing to the activities of the Geological Survey of Canada, a considerable amount of data exists concerning the natural geochemical variation in glacial drift, lake sediments, and lake waters in south-central District of Keewatin. Although originally intended to serve the needs of mineral exploration, these surveys have provided valuable background information for planning water quality monitoring programs in the region. In one case (Kaminak Lake), such geochemical surveying led to the identification of potentially hazardous mercury contamination in surface waters, originating naturally from local mercuriferous bedrock.

Permafrost studies and limnological investigations conducted by Geological Survey personnel have also yielded information about the natural processes that influence surface water quality. Cryoturbation, both on land and in the shallow areas of lakes underlain by permafrost, plays a major role in the transfer of particulate and dissolved drift constituents to surface waters. However, significant gaps remain in our understanding of such geomorphic processes, especially with respect to permafrost activity under tundra lakes, and the long-term effects of such factors as climatic change. Most surface waters in Keewatin are probably highly sensitive to anthropogenic acidification, because of the predominantly non-calcareous nature of bedrock and overburden. Better understanding of the natural buffering capacities of lake waters and sediments is required, particularly in the deeper tundra lakes that harbour important fish populations.

The sediments in many of the lakes examined in south-central Keewatin exhibited conspicuous development of a thick toxic surface layer rich in iron and manganese oxyhydroxide phases, overlying reduced sediments containing abundant authigenic vivianite (iron phosphate). Such sediments are likely of little use for studying the history of anthropogenic trace metal loading, because of the strong scavenging capacity of the plentiful oxyhydroxides and the evidence for extensive diagenetic recycling of metals. Diagenetic effects may also have a substantial influence on lake productivity through retention of nutrients like phosphorus within the sediments. Lakes in Keewatin are probably exceedingly susceptible to disruption from local discharge of such agents as suspended sediment, sewage, and mine effluent, all of which are likely products of human activity on the tundra.

Water Quality Objectives and their Use in Water Management

Thomson, K.W., Water Quality Branch, Inland Waters Directorate, Environment Canada, Regina, Saskatchewan, S4P 3R4

Water quality objectives are an important water quality management tool. Developed for a particular site, in full consultation with all relevant jurisdictions, they reflect environmental, social and economic conditions for that site. Simply stated, water quality objectives are a desirable level, concentration or effect which jurisdictions agree to maintain in order to protect designated water uses. Water quality objectives are closely linked to monitoring practices and available monitoring technologies. Monitoring and special studies are needed in order to develop objectives. Development of objectives also entails consideration of available monitoring technologies for a particular issue or site. Therefore it can be argued that water quality objectives and water quality monitoring constitute a coordinated approach to water quality management.

Preliminary Study of Water Quality in 15 Major Water Courses of Northern Quebec

Langlois, C., Environment Canada, Water Quality Branch, 1001 Pierre Dupuy, Longueuil, Qc, J4K 1A1; Poissant, L., Université du Quebec a Montreal, Maîtrise en Sciences de l'Environnement, C.P. 8888, Succ., A., Montreal, Qc., H3C 3P8

As part of the Canada-Quebec Agreement on water quality surveillance, in March of 1983, the Inland Waters Directorate (Quebec Region) initiated a monitoring program in 16 major watercourses flowing into Hudson's Bay and Ungava Bay. The main objective of this program was to acquire valid surface water quality data in this remote area, so as to evaluate the actual state of the aquatic environment and to detect long-term trends in water quality evolution. All stations were located on gauged rivers, mostly near the mouth. Sampling was done three times a year: during the period of lowest water level, during spring flood and during fall flood. Water samples were analyzed for a wide variety of parameters, including physical tests, major ions, nutrients, metals and organics.

Since it is part of the Canadian Shield, northern Quebec is characterized by very soft waters; total hardness is generally less than 10 mg/L and conductivity less than 30 µS/cm. Total residue (nonfilterable) and water turbidity remain low all year (respective annual means of 2.3 mg/L and 1.6 JTU). Some metal concentrations (aluminum, iron, zinc and mercury) were frequently higher than those recommended by CCREM [Canadian Council of Resource and Environment Ministers] as guidelines for the protection of freshwater aquatic life. Among organics (PCB/OC), alpha- and gamma-BHC were commonly detected and their concentrations were in the same range or higher than in the St. Lawrence River (respective means of 0.9 and 6.8 ng/L). Preliminary multivariate analysis of the water quality results tends to confirm that the long range transport of air pollutants does have significant influence on water quality in northern Quebec.

Impacts on River Discharge of Changes in Glacierized Components of Mountains Basins.

Johnson, P.G., and David, C., Department of Geography, University of Ottawa, Ottawa, Ontario, K1N 6N5

A reliable and predictable water supply is essential to any development, and particularly hydroelectricity schemes in mountainous regions. In regions that have a large glacierized component, changes in the extent of the ice through time can produce surplus or deficit conditions with respect to design criteria. In addition, shorter time frame glaciological changes can result in stream diversion, catastrophic floods or very irregular flow regimes. An understanding of the glacier fluctuations through the Holocene and prediction of fluctuations in the future are therefore central to the design of projects.

The contribution of meltwater to a river system decreases during periods of glacier advance and increases during periods of high glacier ablation and retreat. A picture is emerging of frequent glacier advances which may not be synchronous with readvances elsewhere in the region or with readvances elsewhere in the world. The prediction of readvances is a complex problem involving the understanding of historic fluctuation pattersn together with the potential effects of man on normal patterns. Changes from slowly retreating glacier termini to slowly advancing glacier termini will have a dramatic impact on discharge where a proportion of the flow is derived from glacier melt.

Superimposed in the general trends of glacier fluctuations are more local glaciological effects such as glacier surges, drainage changes through the glacier or changes in the ice-cored debris below the current glacier termini. The dramatic hydrological effects of glacier surges have recently been demonstrated at the Variegated Glacier and the Hubbard Glacier in Alaska. The search for the solution to the mechanism of glacier surges continues, but long-term questions about changing frequency of surges and changing numbers of glaciers that may be affected by surges have major implications to water supply prediction.

There is evidence of severe impact of glacial lake formation and drainage events from many parts of the world. Many glacier-dammed lakes drain annually and catastrophically, and there is potential for many more lakes to form as glaciers advance or retreat. The studies of the glacier-dammed lakes that could threaten the Alaska Highway route were very prominent during the discussions on the Alaska Highway route for the natural gas pipeline.

Other regions are dominated by moraine-dammed glacial lakes. Till or till/ice dams have been breached in the last few years in the Cordillera, in Nepal, in Kazakhstan and in many other glacierized regions as a result of dam overtopping, dam collapse, and landslides or mudflows into the lakes. Flood waves and debris flows from lake bursts are very high magnitude events on the hydrograph.

Ground-Water Quality Issues in Northern Canada

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The study of ground-water issues in northern Canada is still in its infancy. Because of the sparse population in Canada's North, most ground-water quality issues there concern not so much the quality of the grond water itself for drinking but the effects of ground water enters a surface water body. Monitoring of ground-water movement and quality is therefore necessary in relation to the mining industry, where the integrity of holding ponds must be maintained, or where water leaching through tailings piles or mine workings has mobilized excessive concentrations of metals, acid, or radionuclides. Ground-water quality degradation may also occur due to the pollutants in poorly buffered ground waters. On perhaps a lesser scale, municipal sewage effluent has the potential to contaminate ground water through leakage from lagoons before biodegradation of wastes can proceed to completion. In general, the scope of possible ground water monitoring activities is immense, and there are many areas where information is lacking on where monitoring is needed, and for what substances.

Considerations in the Development of Monitoring Strategies to Determine Compliance with Objectives

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Some of the procedures that might be used for testing for compliance with water quality objectives are described. For objectives based on chronic toxicity criteria or longterm percentile requirements, compliance sampling strategies much be designed to statistically represent the frequency of non-compliance in the population of concentrations in the stream. Monitoring for compliance with objectives that are based on acute toxicity criteria or maximum allowable concentrations is most effectively done using sampling strategies that maximize the likelihood of detecting exceedances. Some methods are examined that may allow an effective compliance monitoring strategy for different types of water quality objectives.

The methods considered for possible application are compared to the perceived constraints that such monitoring programs must meet. The sensitivity of the methods in terms of detecting period of non-compliance and the practical application of the strategies in the "real" world are discussed.

H. Vaughan: We have all the working groups present and the working group chairmen are prepared to give their 15-minute presentations. Anyway, the first 15-minute presentation will be from Rod Allan's group.

R. Allan:
Chairperson
Work Group 1

To start off, we spent about 10, 15 minutes just generally talking, so we all got to know each other, and during that time we thought about our objectives. In terms of objectives, it was why are we going out putting water in bottles and all this kind of stuff in the first place. It's not monitoring per se, just monitoring, the real objective is to assess the state of aquatic environments in the North.

Why do we want to do that? Well, we want to determine changes with time, changes upstream and downstream of various things. We want to know what the situation was like before and after developments, and we want to learn just what's out there, what the background is in various places. We want to know compliance, if we meet guidelines and we want to know impacts and effects. Through a general discussion a few of these things popped up as the main sources in the North of impacts and effects. These were mining, and probably second oil and gas and long-range transport of pollutants, toxic rain, whatever. Fourth, settlements and things like hydrodevelopment, transport, and I suppose we could have gone on.

Uses, main uses of the resources were by the mining industry, for fishing, tourism and I had drinking but I changed it to drinking water. Then issues were mining - mining comes up everywhere. Climate change or toxic rain and aquatic ecosystem alterations. So once we got that down, we got around to talking about what we'd been asked to talk about, which was sampling networks and sampling designs and multi-media samples and that sort of stuff. We lumped that together, the multi-media business and the sampling designs and decided to call this sampling strategies to meet that initial objective to assess aquatic ecosystems. We figured there were four levels that we'd have to operate at to do it right; that there was not one magical system to do these things, so there were four levels. The first one we called remote baseline. Half the stations that we have right now are there because the Water Survey flies in to take measurements, so you might as well get some water samples and analyze them, and that's the philosophy up till now and you might as well keep doing it.

However, there are some things that we might want to change. It might be wiser to pick better sites. It might be better to do a little bit more intensive sampling at some of these spots, collect some fish and sediments, maybe even try and get in a centrifuge on the plane and try and get some suspended sediments, get some benthic samples. These are long term, they'd probably go on, some of them forever. Others we thought, after five years you'd probably have a fair idea of what the site was like and you could pull out of it. But since we've been doing these for several years and I don't know how many we pulled out of, but somebody needs to look at the data and sort that out. These stations would be hierarchical, some of them may have lots of things and others may just have one or two parameters. It would just depend. But they're sort of off out in the North, way out in the arctic islands or the Back River and this kind of thing.

The second level is something that we think should be implemented, which is baseline basins. Now this came up because baseline - just getting a few odd numbers at a few odd places didn't seem to keep a lot of people too happy. What we really wanted to look at was variability, and to do that we'd have to go into various regions. Now we figure there are about five physiographic regions in the North - the arctic islands, the barrens, the trees, so on - and in each of these regions we'd have to pick a base and study it in considerable detail, and this would involve flexible sampling, multi-media sampling, intensive sampling. It would be event-oriented, maybe the one in the mountains might depend on glacier melt. One someplace else would be spring runoff. The whole idea would be to assess the variability, and try and get a handle on the baseline variability in each of the five physiographic regions. This would involve field camps. Some poor people would have to go in and stay for months and collect samples, and it might be there for two years; it might be there for five years, depending on how complicated and how much the variations were. But it seems like, to look at a basin and try and understand it, you need about five years.

The third level would be to look at areas of major existing or predicted development, and this would be going in before something happens and staying there till after it's happened, but it's more likely that this would be in two major areas, and the two obvious areas are the Mackenzie Corridor in the Northwest Territories, and the area in the Yukon south of Faro towards the Yukon border, Watson Lake, that Canol Road area. What should go on there is a much more intensive network of routine sites, more parameters. It should

be study-oriented, in other word, very flexible. Go in and do what you need to do to answer whatever the specific question is. There might be specific one-time procedures like coring; you would only do it once. It might be specific chemical intensive studies like Brian Olding's PAH work in the Mackenzie, and it would also involve problem identification by looking at toxicity measurements, maybe looking at diversity indices, that sort of thing, and we'd collect samples for various integrators - fish. Large-volume extractors might need to be used, coring, suspended sediment loads would be sampled, measured, analyzed, so on.

The fourth level would be what we called site or issue specific sampling strategy. This is mainly for impact and effects. Looking at specific sites - an example might be mining. In the Northwest Territories they always seem to be near small lakes or the lake ends up as the tailings pond, and again it would be looking at multi-media, doing toxicity testing, looking for bioaccumulation and impact indices and all that sort of thing. An example of an issue could be contaminants from the atmosphere. That would involve special surveys, limited parameters. Again it would be multi-media, looking at bioaccumulation of specific things, and it might involve complex analysis if we're looking for PAHs or toxaphene, things like that, whereas the baseline would never do that kind of analysis. This would be only one time. The assessment would be done and that would be it.

The last question we were supposed to look at was something to do with objectives, and we didn't do a great deal with this. Just said that objectives were needed, and we seem to need the numbers for regulation purposes. They were imperfect. We thought that it might be wise to add some sort of ecotoxicology tests along with objectives and that locally they would require testing and updating.

H. Vaughan: Are there any questions for Rod on this?

M. Gordon: Yes, I have a question. It's directed to Rod. It has to do with detection limits and things like metals in water. I'm curious; when you're doing your baseline monitoring that you outlined there, and you get nothing but less than detection limits for metals, would you continue to gather samples and analyze them routinely?

R. Allan: No, I wouldn't, but would a routine network continue doing it, I guess they would. Metals are a funny thing, because in a lot of ways most of our metal data are not worth very much, in terms of dissolved metals anyway. I think that at these baseline sites, that

we'd somehow or other haul in a centrifuge and try and get some suspended sediment and analyze that and it wouldn't be too hard to do an extraction to see what the bioavailable content was. The other side is to try and improve the whole dissolved metal analysis scene. That's something that we've been talking about down in the Great Lakes - it would be very expensive.

M. Gordon: Yes, the question, I guess, is in more the application of the data rather than its routine collection. If you're collecting baseline information and it's metal data you're collecting, I guess the hunch would be that perhaps in this area you may see metal mining come in as a development and you'd be in possession then of a baseline data set that you could perhaps use when looking at impact assessment, and monitoring for effects from that development.

R. Allan: I think that would come round to number three here, where we said predicted development where if you thought this was an area where there was going to be some development, you would try and go in and do a more specific detailed study, and at that stage I think you'd have to do the right kind of analysis.

M. Gordon: Why wouldn't baseline data collection start at that stage, and identify those areas that are likely to see development and priorize them, realizing the cost of monitoring in the North here. Why not priorize the areas and monitor the heck out of those first?

R. Allan: Yes. Okay, that's an approach. What we did here is we said at the third level we'd pick two large areas, which would be the major areas for development, so we've prioritized those two. I could see finding smaller areas that you want to prioritize out. Sure.

H. Vaughan: This is a comment directed at that. We did discuss the most appropriate media for sampling. We also did differentiate between a set of indicator baseline stations where you actually might want to just keep in forever, but equally you would have a number of stations that you might attempt to characterize within five years and then just drop. Then if you knew a mine was going into an area that you didn't have such a characterization, at least you'd have information about a similar area. That should give you enough baseline information to assess the kind of changes that that particular mine might have induced. We considered how long you need to characterize a site in the North, and it's a pretty subjective thing, but we came up with the answer that about five years of biweekly to monthly monitoring before you can say I've got it characterized. So you're not going to do that in a lot

of places, but if you can do it in representative areas and then that sits there. There's a characterization of the water quality in this kind of area that is useful to you as such.

M. Gordon: Yes, again the question I guess is what are you monitoring? Are you monitoring rivers or lakes? If you had a scenario as to where mines might develop and you've got all your monitoring stations on rivers and most of our developments for mining occurs on lakes, what good is your information?

R. Allan: Well, you're right. That's true. I mean, I pointed that out excepl the people from the Yukon said that in the Yukon most of the mines are on rivers, they're not on lakes. So I guess it would depend where you are. In the Yukon they maybe would be sampling rivers in these background areas, but I mean the idea is to get the sort of four-level thing. You can't standardize any of these things. What you're saying, it could either be an area of development and you'd say, okay, there are going to be three or four gold mines around Contwoyto Lake, so let's go up to Contwoyto Lake, get fish, get sediment, get water, study the lake, so that when the mines go in, we can assess whether it's had an impact on it. In the Yukon, it might be go to a river like the Flat River and do that in some detail. So that would be sort of one of the three level things. If the mine is in there before you did anything, then I guess you would go to a level four thing where you go in and try and assess the impact and see what the effect is and that sort of thing.

H. Vaughan: It's also probably worth pointing out that the output from this session basically becomes an input to tomorrow's session which is, in fact, mining. The output from today's sessions does not represent the final answers as far as we're concerned. It's just the beginning, to sort of initiate the discussions in this workshop.

T. Day:
Chairperson
Work Group 2 Well, we took a somewhat different approach. We talked more about the program activities. We kept at the program level mainly through the conversation, and that was a natural evolution of the discussion, and I'm not sure what that reflects but that is what we did. In terms of what we said - we didn't say it in this order but this is the way we finally put it together. We, of course, started with the issues, then we looked at the planning phase where we were talking about information and data needs and the concern about approaches. Then we looked at the realities of the situation in terms of existing activities. We tried to make some brief

measure of their success. We tried to identify the gaps and then we said something about gains in terms of the realities of present day life here, and we can say something very general about the future.

In terms of issues, you've heard them all before. There are development issues which include mining, hydrocarbons and long-term interest in dams. There are long-range transport, interjurisdictional issues and, of course, climate change. Each one of these issues requires certain types of information and data and therefore different types of approaches. In our discussion we saw evolving as a common element in information and data needs, the need to focus our activities on aquatic life. We have to take more of an investigative approach and we have to look at what's driving the systems. We feel that these are things that have to be emphasized here as elsewhere.

In terms of the approaches, we didn't go down to the detail that we just heard. We have motherhood things but very real things, where we design programs specifically for the objectives. You can't say that enough. We want the approaches, of course, to be issue driven; we want this business of special studies, and that's very important in the North where you've got so much to cover. I think the special studies is a very good strategy to use. The other strategy that's used up here is taking advantage of the existing Water Survey of Canada hydrometric network for baseline documentation.

It is certainly my feeling as an outsider that there is still a need, a definite need, to articulate the information and data needs and document what approaches are required. I believe that's very important. I think you have to do that in terms of the science that's required, in terms of locations and in terms of priorities and so on. I haven't got a feel for that yet as an outsider here.

The realities of the existing program, again we have the Water Survey of Canada network; we have an investigative series of strategies that are basically opportunistic where we take advantage of NOGAP and things like that. But these are not A-base; these are add-ons; these are again opportunistic.

In terms of success, can we really address the question of how healthy is the aquatic life, and the answer is emphatically no. The Water Survey of Canada network has a series of gaps in it, aerial gaps. It's focussed on the water column, and it does not give variability. We don't know much about the system dynamics.

In lerms of long-range transport, right now it seems to be at the concern stage and we're just developing strategies to deal with it. Interjurisdictional - so far they're addressing only the water column and I guess the sub-set of interjurisdictional is objectives as well as in parks and so on. These things have not yet been locally sensitized, so our success is not great.

In terms of the gaps - I mean it's fairly obvious you need multi-media. It's fairly obvious you have to look at and measure the major systems and the processes. You're interested in knowing how these things work. We're interested in not only doing concentrations, we're interested in looking at loadings - the flux, as somebody called it. Again we're looking at integrators, bioaccumulators. These are the sorts of things you see right across water quality world-wide. There's nothing new about those. There was quite a nice discussion about specimen banks as a way to retrogressively look at impacts or issues, and again there has to be more, or certainly some work focused on site specific application of water quality objectives.

In terms of gains, and these are gains that we can do in the short term where it's not going to require major influxes of money which don't exist. We figure the biggest thing that can be done is simply one of co-ordination. There are certainly a number of agencies working across the Northwest Territories and the Yukon, northern Quebec. There's much to be gained by information transfer, technology transfer, but particularly joint work. I again feel as an outsider that before that can happen successfully some sort of framework or activities must be developed so people know what is going on, where it's going on, what are the objectives, and so they can see how things fit in.

We didn't talk too much about the future because we all know what it needs. It just needs good planning, good execution and obviously a lot more money. So, that's an overview of what we did. Any questions?

H. Vaughan: Next, John Lawrence.

J. Lawrence:
Chairperson
Work Group 3

Our group took yet another approach. We decided that one common theme that was running really through all those questions and through most of the presentations that we've heard in the last couple of days, was really that of data quality, and since a number of the people in the working group were, in fact, lab-related, we decided to devote most of the time to a discussion of

data quality and quality assurance and quality control. Not in a particularly sort of general context, but more how it pertains and how it has to be different in cases where you're working in the North. We discussed it both from a chemistry standpoint and that of bioassays.

In terms of who is doing what up here, we essentially have the DIAND lab, Water Quality Branch, Environmental Protection, a number of mining companies and private analytical contract labs, and between all those labs there already is a sort of healthy awareness for quality control, but it is necessary to bring all the labs up to the same level. Essentially, all those labs were involved in two types of activities - well, they weren't all involved in two, but among them they were involved in two types of activities. There's the compliance monitoring for licencing and then there's the background or trend monitoring.

We went through a fairly general discussion of quality control, quality assurance, the fact that it consists of the field component, the lab component, the between lab component. Dollars raised their ugly head at several stages but we decided in order to get anywhere within a couple of hours, we left the resourcing issue aside, and then we went on to a discussion of some of the more - well I'll call them the more exotic components of quality assurance, but they're really just as essential. It's just the fact that in the past they've never been given the same amount of attention, and that is the whole question of quality assurance management plans, plans that are drawn up at the conception of a project so that everyone understands what is required and the level of competence in the final data. There's the need for full and thorough documentation. There is the external audit function which again many people talk about but usually, because of limited resources, it's something that's usually left undone.

We also got into a question of lab certification and that ranged from a formal certification program, which no one within the Canadian government is in fact carrying out at the present time with the exception of a small program being initiated by the Standards Council of Canada, but that's only the formal part. So the informal side of lab certification, there are many times when either through sending blind samples to a lab or something, you verify for yourself that a lab is performing reasonably well. That, in a way, is a form of certification or accreditation.

We then went through the various components of a program, the field part. There's the site selection, sample collection techniques, sampling frequency, the mundane things like bottle washing, replicate sampling, splits, blinds, duplicates, etc., preservation techniques that are required particularly if there's a lengthy delay between the time that you pick up the sample and the time it's analyzed; shipping problems, the fact that everything in the field must be recorded in much the same way as it has to be in the lab. In other words, the discussion included everything to ensure what, for want of a better word, we'll call sample representativeness, which is a horrible word but I think it gets the message across.

We then went on to discuss the within laboratory part of quality control, and that is everything from the time you receive the sample, the receiving process, storing, the choice of analytical methodology, calibration of instrumentation, the use of spike standards and replicates within the lab, control charting, training of staff and certification of staff, which again has to be an ongoing activity. What we decided was that all these things are things which any lab can essentially do right now. There was some concern expressed, particularly amongst some representatives of some of the smaller laboratories present, that it's great to sit around and talk about very large quality control plans, quality assurance plans - these things take months, in fact years to develop. It takes years to develop the necessary manuals that go with them, but what can they do right now, and in fact these are all activities which can be done right now. I think you'll find that most labs are already carrying out most of these activities, however they may or may not be calling it quality control, and they may or may not be documenting it. So for very little additional effort, if they're not documenting it, they are already well along the way to having some form of quality control program.

Then there's the use of the interlaboratory quality control programs, the round-robin activities, the use of certified reference materials and reference materials as blinds, and really if all labs have internal control of their operation, the only real reason why you need an interlab part is essentially a check on between laboratory consistency, and it really is just a check whether you've got your own in-house activities in order. There's also the question of data handling which is part of the overall quality assurance activity, but we didn't discuss it, we ran out of time.

So we came up with some recommendations. First, the group strongly supported the DIAND initiative to develop quality assurance, quality control procedures. They have, in fact, developed the beginnings of quite a sophisticated program, both within the Northwest Territories and tying their own laboratory here into some of the programs in the southern part of the country so that in fact they've got a secondary calibration there. Leading from this activity that DIAND have undertaken, there is really a need for a co-ordinating committee within the Yellowknife area, either as a separate committee or maybe it can just be given as another duty to an existing committee, and that committee could, in fact, then in turn be tied into the Water Quality Branch National Technical Committee on QA/QC.

There's a need for standardization of protocols in all the documentation processes, and there is the need for some consistency in the manuals that are being used, recognizing that some of the smaller labs wouldn't be able to go to the depths that the larger labs can. However, if you have a standard manual and stipulation as to what the minimum requirements are, then everyone can do the minimum component and the bigger labs can do stuff over and above that.

The fourth recommendation was that quality assurance should include field activities, both from the compliance component of the program and the ambient monitoring. There's a need for a QA/QC management plan to ensure consistency between various activities as evidence that the data generated are, in fact, what they appear to be, and to provide overall confidence and a degree of confidence in the numbers generated.

For the final three recommendations there is a need for regular external audits. There is a problem with resourcing these, but there is no real reason why people cannot come to an arrangement whereby they essentially put audits onto each other's labs or having one person up here tied into someone in one of the big national labs maybe who could do audits on an occasional basis. There is a need for a water quality laboratory of some kind in the Yukon, particularly for the analysis of immediates, and this is going to become even more apparent when the Yukon federal agreements are negotiated. Lastly, there is a need for documentation of the various preservation procedures. In fact, we have been doing some of this in Burlington over the last few years. Some of the documents have been written up; some of them haven't, and I'll make sure that these are made available as and when we've completed them.

R. Kwiatkowski: John, I fully agree with the concept of QA/QC, but I sometimes have difficulty in my own mind visualizing how much effort should go into QA/QC. Just how accurate a number do we want, especially when you take into account, and as many people have stated today, that there are such things as diurnal variation, seasonality, and hydrological cycle, which can result in changes in concentrations between one day and the next of an order, perhaps two orders of magnitude? Also taking into account that often data are used to calculate averages over ranges which are two, maybe three orders of magnitude, are we spending a great deal of money to get an incredibly precise number, and then using that information as an incredibly imprecise tool in our data reporting?

J. Lawrence: Not necessarily. One of the reasons that it's very important to have a quality assurance management plan in place to start with. That plan should spell out (a) what you're trying to do with the data, what degree of confidence you need in the data, and then you can design your measurement program to go out and collect data to that degree of confidence. If, in fact, you're looking at something where you've got a daily variation of three orders of magnitude then, sure, I agree with you. There's no point in wasting a lot of effort collecting accurate numbers. On the other hand, if you're going to quote numbers of 9.8, 10, 10.2, then we need to know whether those are really 9.8, 10 and 10.2 or whether they are really 10 plus or minus 6. But if all that's spelled out to start with, then you can design your program accordingly. If you come along after the fact, you're not going to be very successful.

H. Vaughan: Certainly, there seems to be a commonality of ideas kicking around all the various agencies and people present, as shown in Rod Allan's group and Terry Day's. I think we now have to face the fact we're going to have to priorize some of those ideas. Logistic costs being so high, we can't really afford to do everything, but if we can manage to priorize with reference to specific issues which we will be discussing over the next couple of days, such as mining and hydrocarbons, then perhaps we can begin to address the actual details of design. The third presentation by John Lawrence I'm quite excited about actually, when I think that if we put a quality control plan in here we may do away with an awful lot of logistical costs.

End of Session 3

Session 4
Mining

Session Chairperson: Mr. Dave Nutter

A Framework to Improve the Effectiveness of Aquatic Environmental Impact Assessment

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This paper introduces and applies a conceptual framework developed by Lars Hakanson, National Swedish Environmental Protection Board. The framework addresses the causal relationships linking contaminant doses with responses in aquatic environments. The paper is focused on metal contaminants and presents a northern case study in which the framework was applied. The approach emphasized the environmental factors regulating the potential effects of contaminants and stresses the importance of understanding physical environmental processes in monitoring design and selecting information with linkages between the contaminant dose and impact on valued ecosystem components.

The approach uses concepts of ecological effects, dose and sensitivity, and provides a basis for communication among participants in environmental impact assessment. The potential risk index developed tentatively accounts for "biological contact area," "biological contact time," and additive effects and their importance in ecological contexts. Fundamental to this empirical approach is the residual term which indicates the level of understanding of the ecological system with respect to the potential ecological effect.

The case study involved data gathered for the Lupin Gold Mine water license, Contwoyto Lake, N.W.T., and subsequent data collected under a research contract. The framework was applied to assess potential data gaps and/or redundancy and to develop a rational, practical monitoring program to assess and predict potential effects of tailings water discharge. Initial conclusions indicate that the framework can be a useful tool to improve and rationalize environmental impact assessment procedures such as those used at the mine.

Progress Towards Standardized Programs to Monitor the Effects of Mining Developments on Lakes in the Northwest Territories

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Environmental Protection of Conservation and Protection, Environment Canada, has undertaken a program to produce guidelines for monitoring impacts from mining developments on lakes in the Northwest Territories. There is a need to standardize monitoring programs to ensure that data collected by different agencies or companies are of high quality and comparable. In too many cases, pre-development data sets and data collected during the life of a mine have been obtained by different

project teams and the data are not comparable. As well, the quality of data has often been neither compatible with the types of regulatory decisions to be made nor of suitable quality. Mining companies have requested that government provide some consistent guidance with respect to the content of an effective monitoring program so it can be implemented at a reasonable cost.

Environmental Protection has prepared draft guidelines for programs to monitor changes in water quality and sediment chemistry, and these will be finalized over the coming year in co-operation with other government departments, the mining industry, the consulting community, and experts from the research community. In addition, it is expected that guidelines for biological monitoring will be produced over the next 2 to 3 years.

The guidelines provide a framework for establishing the level of sensitivity necessary to detect an appropriate level of change, as well as overall program design. Guidance in the areas of sample collection, sample handling, analysis, data reduction, reporting, and quality assurance/quality control (QA/QC) is provided. Protocols for station selection, gear selection, determining sample acceptability, and field and laboratory replication are also presented.

In preparing the guidelines, issues arose which will require collective decisions involving groups that collect the data as well as those that interpret the data and apply them to decisions. Specific issues that will require consensus include:

(a) Detection Limits for Metals in Water . What are the detection limits that are useful versus what detection limits can be achieved given the realities of sample contamination in field situations without clean room facilities?

(b) Optimal Versus Sub-optima l Program Design. An optimal design is clearly preferable, however, it may not always be practical.

(c) QA/QC . What level of data quality and QA/QC is appropriate, and how should a QA/QC program be organized to ensure data quality is maintained and to ensure comparability between data sets produced by different study teams?

Suggestions are presented in the paper. The final resolution of these and similar issues, however, will rely on the collective views of agencies, companies, and researchers involved in monitoring mining impacts in the Northwest Territories.

Treatment of, and Gold Recovery from, Effluent at Giant Yellowkinfe Mines Limited

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The milling of refratory gold ore at Giant Yellowknife Mines Limited results in several effluent water streams which are combined and sent to a

tailings pond. Prior to being released to the environment, tailings effluent is treated to make the solution environmentally acceptable. This involves removing contaminants such as cyanide, arsenic and heavy metals. Initial investigations into various treatment processes to remove cyanide and arsenic showed that alkaline chlorination and iron salt precipitation as the best available technologies. In 1976, Giant Yellowknife Mines and Environment Canada entered into a DPAT (Development of Pollution Abatement Technology) program to investigate various treatment processes for the removal of cyanide and arsenic, including those stated. In August 1981, the Effluent Treatment Plant became operational employing an "alkaline chlorination-arsenic precipitation-flocculation" process. This paper describes the development of the effluent treatment process, process chemistry, plant facilities, plant practice and reviews the Effluent Treatment Plant performance over its six seasons of operation to date.

Subsequent analysis of the discharge from the Effluent Treatment Plant in 1982 showed that recoverable quantities of gold were being discharged to the environment through the final decant. Laboratory test work showed that these gold values could be effectively recovered on activated carbon by passing the decant solution through a bed of activated carbon. A description of the various carbon column configurations used and an operational and cost analyses for each are included.

The Influence of Coal Mining Activities on the Quality of Stream-bed Substrates in the Fording River, British Columbia: A Preliminary Assessment

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A total of six sites, with similar physical and hydraulic characteristics, located upstream and downstream from an existing coal mining operation were selected to assess the influence of mining activities on the quality of stream-bed substrates. The particle size distributions of gravel-bed materials were described using substrate statistics commonly found in the literature. Statistically significant differences ($p < 0.001$) between upstream (control) and downstream sites were detected in the percentage of sediments smaller than 2.00 mm and 6.35 mm. The differences between upstream and downstream sites were also statistically significant ($p < 0.005$) for the variables' geometric mean particle diameter and Fredle Index. Differences between areas were evident for both sampling periods (September 1985 and April 1986). The biological significance of these differences in stream-bed composition was examined using empirically derived egg to fry survival models for salmonids currently available in the literature. The preliminary results of this study suggest that activities associated with coal mining can increase the content of fine sediment in stream-bed substrates, and thereby compromise the production of salmonids when stream reaches downstream from the development are used as spawning habitats.

Radiological Monitoring Activities in the Northwest Territories, Canada

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Radioactivity in the aquatic environment originates from natural sources and man's activities. Natural sources of radionuclides include those from the interaction of cosmic rays with atmospheric nuclides, primordial radionuclides, and weathering of minerals containing natural uranium and thorium. Man-made sources of radioactivity in the North would mainly come from the mining and milling of uranium ores, and the fallout of radionuclides from atmospheric testing of nuclear weapons. Environmental significance of both sources of radioactivity will be discussed.

Canada possesses significant uranium mineralizations which may affect the surficial water quality. The National Radionuclides Monitoring Program was initiated in 1981 to assess the present status and trends in surface waters across the country. Four years of monitoring data from the Baker Lake site will be presented and their environmental significance discussed. Also, plans for monitoring in the future years will be discussed.

Uranium mining and milling activities at Port Radium and Rayrock, Northwest Territories, have left large quantities of uranium tailings on the surface. During the last 10 years or so, the Departments of Environment, Indian and Northern Affairs, and National Health and Welfare have studied/monitored sites for their environmental impact. Relevant data from these sites will also be presented and discussed.

The Impact of Effluents from a Uranium Mine and Mill Complex in Northern Saskatchewan on Contaminant Concentrations in Receiving Waters and Sediments

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Uranium has been mined in northern Saskatchewan for more than three decades, and at present, the province's three operating mines account for approximately half of Canada's production. Amok Ltd. operates one of these mines at Cluff Lake, approximately 175 km south of the Northwest Territories and 30 km east of the Alberta border. The present paper deals with the impacts of the mine effluents on downstream receiving waters and sediments. The downstream water studies were conducted on Island Lake on the Island Creek drainage system; this system later enters the Mackenzie River drainage via Lake Athabasca.

Discharge to the environment commenced in March of 1982, and since then has averaged more than 100 000 m^3 per month. All effluent is treated before release in a multi-stage process of settling, chemical treatment, further settling, further chemical treatment and final polishing by sand filtration. The effluent treatment system's results are considerably better than those required by the federal and provincial control agencies, but the effluent still contains measurable amounts of several radionuclides and heavy metals, and substantial amounts of some major ions. The contaminants studied in this paper include five radionuclides, seventeen metals, and seven major ions.

Effluent discharges from the treatment system are monitored weekly for the major ions, radium-226 and uranium. Most of the other contaminants are monitored on a monthly basis. Receiving waters are monitored monthly at four downstream locations, but the primary focus is on the lake immediately downstream from the discharge point, Island Lake. Sediments have been monitored annually at Island Lake for radionuclides, and for the last two years for several heavy metals. In addition, a quantitative study was undertaken in December 1986 to determine absolute loadings of uranium and molybdenum to the lake sediments.

These studies are significant because the Cluff Lake site is the first Canadian uranium mine for which extensive baseline data were acquired prior to development. When this is coupled to an extensive monitoring program during the operational stage, the site offers a unique opportunity to quantify the impacts of uranium effluents on the northern environment. These data will assist the prediction of the environmental effects of proposed new mines, and assist in interpreting the database associated with older uranium mine sites.

D. Nutter: As you know better than I, following the scientific sessions this morning on mining you broke into work groups again this afternoon to review the monitoring in the context of mining, and we'll go through the three session chairmen to review what their various work groups came up with over the course of the afternoon's discussions. So we'll start off with Bill Duncan.

B. Duncan: Chairperson Work Group 1 We started out asking the question, what's important and what do we want to measure? I don't know if we got right down to a specific answer to that, but we certainly had some ideas of how we could start to look at it.

The answer. We divided the mining process into four phases, the first one being exploration. We looked at exploration as a time for, or an opportunity to gather baseline data. Characterization of the water body in that area, and certainly it is in the mine's interest to characterize the rock, and at the same time possibly they could be characterizing the water body. But we decided that exploration wasn't necessarily a real problem in itself.

Then we went on to the development process. At that point you'd be wanting to characterize the process, effluents and controls, and identifying the treatment processes that you're likely to be using on this ore body. It may be the appropriate time to do a more accelerated baseline data. If you're getting to the development stage you know the mine is likely to go ahead. This is when you could start increasing the amount of data that you're collecting.

Then we got into the operating phase of the mine. At this stage of the mine you'd want to be monitoring the process, effluents and impacts of the mine. Obviously, you want to optimize the mining, or your sampling process, and we got into a long discussion about site specific - things common to a site. I kept trying to direct the discussion to developing a list along the lines of what Glen had produced and everyone kept saying, we don't want to do that unless we know the site, and what kind of mine it is. Also, at this time you'd really want to rationalize, your mine's in an operational stage and it's going to be operating for years on end. This is the time when you'd really want to make sure your monitoring costs are rationalized and you're not doing anything that you don't have to be doing.

In the characterization stage and the first few stages you might be doing some stuff that from the mine's point of view is totally irrelevant but from a water quality point of view is, but once you've characterized the system, maybe you just need to monitor what we said here, the process, effluents and impacts.

Then we got into abandonment. Length of time: how long do you monitor after abandonment, and that's a question there because we never really did answer. Then we got down to the question of costs and responsibility. Who would be responsible for doing these various things, and what I'm presenting here is just ideas that came out. They're not trying to say this is how it should be or anything, but these are just different things we battered around and we did have a diverse group there and we did come to "some kind of agreement."

Exploration. It's probably a co-operative approach, both mining and government working together and suggested that maybe we'd have tax incentives at this stage to make it, as there is tax incentive for exploration anyway, but kind of tax incentives for the environmental part of the exploration. Development. There's kind of a basic cost associated with getting the data for development and your impact assessment. This may or may not be shared. Then you get into the operating of the mine. We discussed a lot about the cost and who was going to pay, and the basic cost we're talking about here would be kind the routine things that to a large degree would fall in the area of the mine. The things, the routine monitoring that you have to do, and this would be process, effluent and impact monitoring.

There is a problem with mines and that is that mines are various sizes. They go from small to large, and obviously a small mine cannot afford to pay what a big mine can to develop a site. So we had to come up with some way of trying to make it fair for each mine, and basically that's where we've come up with the basic costs. There are basic costs; you have to do some monitoring, regardless of the size of the mine, but that there might be kind of a stumpage or extraction costs on a cost per ton basis that can be used to do the special research and impact assessment type work that needs to be done. It's probably again a cost sharing program, because we got into a lot of argument of what responsibility government has to the mining community and what responsibility the mining community has to the rest of society. Again we got to the size of the mine and the most fair way we saw would be to have a kind of extraction or stumpage fee. It would also help to provide a fund for abandonment, future abandonment of the mine.

We discussed abandonment: the costs of abandonment; who pays the costs; what happens if the mine goes belly-up? It was suggested that a bond issued by the mine, a performance bond up front, would be a good idea.

Then we got into social and economic and other aspects of abandonment. When does the mine's responsibility end? Ten, fifteen, twenty years? Ad infinitum? Again, the bond was necessary because maybe this was the mine's only mine and they're going to be out of business after it. Also, monitoring and restoration and basically monitoring during the abandonment phase. Who's responsibility is it?

We discussed the need of technology transfer. We have a lot of good researchers here in our country and other countries that are doing work in this area. Somehow this information has to transfer out into an applied sense, that it can actually help the resource managers who have to deal on a permitting basis or a licencing basis. We got into a lot of discussions about cost sharing and just general co-operation between everybody to most wisely use the limited resources that we have available to us.

Getting back to one of the things we were supposed to look at on the sheet, assessment and management. We talked about the need and agreed with the need of site specific objectives, and that from a management point of view, from someone who has to manage the resources, that probably objectives are good. Even though numbers have problems with them, a manager can't be a technical expert and he has to have something to make a decision by. We discussed also that more research is required to make the decisions and to provide the manager with the tools for good decisions. We discussed at great length the problems with changing priorities and some of the conflicts that have arisen out of rules changing midstream. The idea of what happens if an unforeseen impact occurs that no one predicted. Who's responsible, the mine or society or government?

P. Whitfield:
Chairperson
Work Group 2

We took a somewhat different approach than the previous group. We talked about a holistic approach; we talked about types of mines and types of mining and milling processes which would affect things. We talked about scales and we spent a fair amount of time talking about various different scales of activity that we perceived were important or interesting. We talked about site specific and mine driven activities and we talked about basin activities and basin driven activities. To try and tie it all together.

In terms of holistics, we talked about worrying about more than just the end of the pipe; worrying about all the discharges, all of the activities on the site that cause materials to enter the ecosystem, stuff that goes through ground water, stuff in surface runoff, stuff that goes out of a mill through a stack - all the different kinds of things that we currently maybe monitor indirectly, but we never get a real good feel for all of the materials that are coming out of the site. We talked a lot about being able to measure the total discharge of materials from the site, in terms of the total end of the pipe, the ground water, the runoff material, and that which goes through the atmosphere either through stacks or through wind transport.

We talked at length about types of mines that are currently active, or have been active. We basically grouped them two different ways and had an interesting discussion about how the mines operate. We talked about the currently operating hardrock gold mines, the base metal mines, the uranium mines, the former asbestos mines and placer gold mines. Another way of dividing those same mines was to divide them into the sulphide mines, the non-sulphide mines, and the placer, and this is particularly important when you consider the problems with acid mine drainage and the perception of mines that are acid generating, always seeming to do it after abandonment.

We talked about the processes that are used in the mines and in the mills. What are the chemicals that are added or produced by the mine and can we worry about some of those being toxic; can we use some of those as tracers? We talked about mine driven activities and particularly about site specific things. We had a general consensus that we were very concerned about mass balance, knowing the total amount of material that we're really dealing with and not just what we are measuring on a once-a-week sample out of the end of a pipe, although there was still support for end-of-pipe measurements, still recognition that we need to worry about the compliance with licence terms. Again, things about tracers and labels we could use to understand better the materials that are going through the surface water systems and maybe the ground-water systems.

We talked a little bit about the zone of influence and how do we perceive the zone of influence and do the regulatory agencies and the mines that currently do the monitoring at the sites, are they really covering the whole area that is being influenced? We talked about monitoring in terms of legal needs. The mines have licences they have to comply with; these are legal

needs for which they have to fulfill the requirements. We talked about the problem that each mine is unique, that you cannot generalize, and we talked about a desire for work to become co-operative rather than confrontational.

On the basin driven side we talked about basins as being unique in the same way that mines are unique. We talked about integrators and being able to have a feel for things on terms of what the total impact on the system was rather than spot samples. We had a general consensus that the ecosystem approach was a viable one; that we were very concerned and needed to be able to better assess basin-wide effects and basin-wide risks. We talked about loadings and concentrations. Different situations rely or require you to have an understanding of loadings in the aquatic systems. We tend to see total amount of materials being estimated through rather crude techniques. In ground-water systems, sometimes concentrations are more important, and if you're considering chronic and acute effects, either one of those could be the important part.

We talked, and I think the real crux of what we talked about, was perceived needs. There are real legal needs and environmental needs to monitor at the site, but nobody is quite prepared to step back and say we don't need monitoring at the basin. If we just worry about the minesites, we'll let the basin look after itself. There won't be an effect, and yet nobody is comfortable with making that determination. Everybody perceives that we need to do something on a basin-wide basis.

So in terms of trying to summarize all of the different discussions, we talked about being sure that we identified the problems; what we are really concerned about, and what effects we need to be concerned about and letting the problems drive what we do. We talked about basins and focussing on some of the basins, and recognizing, particularly in the Northwest Territories, you cannot monitor every river basin that has mining in it. We talked about and agreed that we should be considering both affected and unaffected basins so that we have an understanding of how the two of them relate to each other, as a way of measuring what the total impact is. We wholly support the system approach where we don't just look at the end of the basin, but we spread our activities through the basin.

We talked about tools and the tools came down to two questions: do we have the right tools now, is there something that we can do that will work, and no one had something they could guarantee would work. There are tools and a lot of them that presently exist need to be

evaluated further and tried, and we also need to keep our eyes open for new techniques that can be applied to the problems. We need to learn from history. We talked about material coming from outside the North, and I think the point that came across was, we should learn from the mistakes of the south and not try and learn them again the hard way.

We still have problems with separating the long-term load discharges from the mines and periodic discharges such as major spills and effluent ponds entering the system through chance events. Basically, it's how do we rectify the situation; how can we measure both the long-term effluent effect and an episodic effect, and everything came back to this idea of co-operating, sharing ideas, sharing expertise and learning from each other. And that's all we have. Are there any questions?

M. Gordon: This is, I guess, followup to a question I raised yesterday, and it has to do with what I perceive is a hangup on basins and not lakes. Obviously, there's a difference between how one would approach monitoring in Yukon relative to the kind of mining that's going on there, as opposed to what we do in the Northwest Territories, and I'm just curious - your discussions, were they focused mostly on Yukon mining activities?

P. Whitfield: We had one mining expert in our panel. We talked a lot about that specific mine and lessons we could learn from that. No, there was no intent to focus. We talked about systems, without specifying whether they be river systems or whether they be lake systems. A case in point, systems here where you have lakes and chains of lakes, do you study just the first one until it goes and then start studying the second one?

M. Gordon: That's my point, yes. It's scary.

P. Whitfield: We're trying to say, let's look at the whole thing and get a feel for the whole thing and where is the impact and how far does it go, and how does the system work together.

M. Gordon: Yes, I guess that's my point. It's a little scary if we're only willing to monitor rivers and ignore what happens in the lakes that feed them. By the time we pick up a perturbation in a river that's coming from a lake, I guess we could pretty well write that lake off, or the lakes upstream that lead to your monitoring station. I'm just curious, is that the way

we want these things to go in the North? Writing off lakes or maybe river basins? It's a question maybe

without any answer for this particular group, but it's something that seems to have permeated the discussions in the last few days and I just thought I'd better...

P. Whitfield: Historically, Inland Waters/Lands [IWL] Directorate has monitored at the end of the basins, and many of the basins - and this also applies to the Geological Survey in the U.S. and other agencies around the world - where end of the basin was what was measured, and what we tried to focus on is saying, well, if something happens in the basin by the time you measure it here you've written the basin off. What you need to do is understand how that relates to everything that's going on in the basin and study the whole basin rather than the end of the basin.

M. Gordon: No, I understand that's a traditional IWL approach. I guess the question that I would ask then, is what use do you expect to make of the data if you're looking at a much larger system, but you're concerned about what's happening in the smaller systems like lakes? What use are the data? I guess, again, that's a question that you can't answer, but maybe it's something we should think about.

P. Whitfield: No, I have no trouble with it. Systems that are lake to lake driven really, that's where you need to be looking. But we're trying to look at something - we talked about things on a regional scale, and really are dealing with orders of magnitude differences in scale and in focus, and it really is hard to come up with one approach that's going to do both.

R. Kwiatkowski: It's a comment not a question. I think the point here is that in a river basin we are including lakes. The definition is, are lakes nothing more than wide components within a river; are rivers nothing more than narrow lakes. I think we get hung up on jurisdictional problems of who's monitoring what. When I think of a river basin, I think of everything from the headwater lakes right down till it empties into the ocean, and I think we should be looking at those kinds of systems.

M. Gordon: Yes, I understand that, but it strikes me that if you have but one monitoring station on a river system and you're concerned about a mine on a lake upstream, and I guess I hate to use the phrase, but mixing zone and all that it implies, you've allowed the mixing zone to extend from the mine to your monitoring station, and include all the lakes and waters upstream, and I would be personally concerned about that sort of approach to monitoring for effects from mining. Again, it begs questions to look at valued ecosystem components; are we looking at resources within a lake or within a

basin? My answer would be in the lake. I guess it's not shared by everyone. Thanks.

P. Whitfield: No, I don't think - I just think we're not communicating. We're talking about whole basin studies, not just lakes; not just rivers, but understanding how the whole river basin works, and what the effect on the whole basin is. Maybe, being from the Yukon we have, other than the headwaters of lakes, we don't have a lot of lakes in our river systems, and we have very high slope systems and so we don't have them. But you do, and that's the principal - that's where the major part of your ecosystem is, is in the lakes, and if you weren't studying them I would be very concerned. But still the question is to go to a regional or to a bigger scope, how do you accomplish it, because studying the one lake down below the mine doesn't answer all the questions. It may be that all the resources you have is to do the one, but if there's an impact on that lake the question immediately is, is there an impact on the river stream, river section below that, and the next lake, and the next lake?

M. Gordon: Yes, but it's still - it becomes an issue of containment really. If you can contain the impact within a lake, who cares about the river downstream?

P. Whitfield: No, I appreciate that.

M. Gordon: I would rather think that's the whole purpose of pollution control is containment within a limited and known area.

P. Whitfield: We talked about that and I presented some material on that, the fact that we have a perceived need to do something on a bigger scale than just the minesite, and we had some very interesting discussions because it gets very controversial. Everyone says, well but we won't be able to measure effect. You're forty miles away from it. By the time we measure it here, you're going to have wiped out everything in between. But, on the other hand, no one is willing to say we shouldn't do any monitoring on that scale at all.

M. Gordon: I wouldn't deny it. We can use a lot more data, but I think perhaps the effort should be focused at answering the immediate question, which is what kind of impact the mine is having in its immediate area not on the river forty miles downstream.

B. Olding: There's no need to do lake monitoring if the regulatory system is working properly. However, the regulatory system isn't perfect; therefore you want to do lake monitoring. Now there wouldn't be any need to do any

regional monitoring at the bottom of a system permanently or periodically if we knew the lake system was perfectly done, but it's not. To just leave the bottoms of the basins untouched and not look at them on the assumption that it's always going to be taken care of because you're monitoring the obvious trap from the impacts, the lake below the minesite, leaves me a little uneasy. So, I think the point is that we need some type - I don't know what type it is right now - but we need some kind of bottom of the basin integrator, which is not just concerned with one mine but the entire impact it's receiving on that mine. It's there, that we can go back to, and compare, after a baseline is laid down, we can come back and compare whatever cumulative effect that's taken place there. That doesn't negate at all the absolute need for the first lake downstream of the mine as an impact assessment specific to that mine, but if you have a number of tributaries, number of mines, and you're down at the bottom of the basin, what do you do? And that's what I think we were trying to get across in terms of a basin approach.

G. Packman:
Chairperson
Work Group 3

I think we had all the Yellowknife people in our group and maybe too unfortunates that got stuck in with us. We had Giant and Echo Bay and all the people on the NWT Water Board's Technical Advisory Committee and it was a rerun of a lot of discussions that we've had in the TAC.

We looked at compliance monitoring and we looked at ambient monitoring as two separate things. There may be some problems with compliance monitoring, with data quality or whatever in an individual situation, but generally it's a manageable problem and we know what the problems are and we can resolve them and they are resolved. If you get into a situation of perceived non-compliance, then the check samples are run and things are fairly quickly clarified.

In the ambient monitoring we concluded that there were two types of monitoring there. One, the broad-based type of program that IWL does where you've got basin studies and so on. The point was made that we can't really expect that network to provide information on a site specific basis for mining developments, because it's just so difficult to guess where mines are going to go.

Then we looked at receiving environment programs and downstream effects. We agree that with these two, we've major problems. We did come to some agreement, however, that the programs are generally unfocused, and there doesn't seem to be any way of focusing them. It's hard to tell what the programs are designed to do,

and therefore when the data come in, they do not really suit the objectives and it's difficult to draw conclusions from the data. And a resounding consensus, of course, was that the current system isn't working very well.

The current system of deciding what a program is before you actually go out and study it. We managed to get some recommendations out at the end, which was that the whole problem comes down to the fact that we don't know what it is we're trying to accomplish in monitoring. We don't have a clear statement of what it is we're trying to protect and what the objectives are for managing a watershed? Are we trying to protect fish in a given bay? Are we trying to protect fish in the whole watershed? Are we trying to protect water quality for drinking? Or what is it we're trying to protect?

We're recommending that there's a need to clarify these, possibly on an application-specific basis, or a mine-specific basis, but these things have got to come down from the decision-making level, almost the political level as to what we're trying to accomplish. We agreed that you could develop guidelines for how to monitor something in a given situation; how to take sediment samples, how to take water samples and so on, but to actually design a program, clearly they have to be site specific, and they have to be related to those objectives.

We need to incorporate quality assurance, quality control in programs, and maybe the best way to do that is to incorporate those things up front so that you know what data quality you're going to be working with throughout the program, in the pre-development studies and in the post-development studies. If we can get that sorted out up front we'll go a long way to resolving the problems. The programs should be specifically designed to support the licencing process. In other words, you should be designing to have data come in before a Water Board hearing at the initial licencing stage and data coming in before the re-licencing hearing so that you have some information in front of you to decide whether the licence is working well or not.

We need a mechanism for making decisions about data requirements and program design up front. Whether this is the Technical Advisory Committee to the Water Board or the Environmental Advisory Committee wasn't really resolved, but we need a mechanism, for instance, so that the three government agencies can sort out what they're going to do before data collection starts.

That leads to the last recommendation. We need more interagency co-operation.

And finally, the central problem is that it's difficult to set objectives because there isn't anybody out there, and the only people out there are the people mining, so what are we doing? Are we protecting aquatic life, are we protecting drinking water, what have you? And no one's telling the regulators or the managers the answer to that question.

B. Duncan: I couldn't say this when I was presenting our group's discussion because we were supposed to be presenting our group conclusions, but I'll say it now. I see a real problem here, I see it as the same problem we have with politics to a degree. We have a pendulum swinging here, and there is a real need to develop site specific programs, and I agree with that, but I am concerned, I've seen it in work I've done for the provincial government back home, in that there are a certain number of basic parameters that really are general to characterizing a system, and some type pollutants that I do think have to be included in any monitoring program. I just know a recent example where we're looking at using some mine waste rock and I'd suggested a few extra parameters and because of cost consciousness or whatever they were cut back to two, that's all that they wanted to measure. It's a function of lab costs. The philosophy before was to measure everything under the sun, and now we're going back to measuring one element, and I think if that pendulum swings that way we're missing a bit. I just wonder in your group, did you get much chance to talk about what would be a base, a minimum you need to monitor in a system, to characterize it?

G. Packman: We didn't really. We went around the gamut of things that all the people at the table had been around many times before, and this was do we monitor water, sediment, benthos, and I think if we got any commonality out of that, the agreement was that yes, you monitor them all at the appropriate time, but you can't draw a conclusion that you monitor all of them all of the time or one of them all of the time. I agree with you, myself, that we shouldn't be too restricted. When you start getting down to two elements, I think you're really limiting yourself further down the line and it's probably bad economics.

B. Duncan: Another point I'd just like to make, this morning when you talked about determining the detection limits and going through that process of limits of detectability. The types of detection limits you were talking about and the procedures you'd have to go through to get

those types of detection limits both in the field and in the lab indicated that obviously we were sampling the wrong media for those parameters, and that we do have to, in a water a licence, look at other medias and not worry about measuring some things we can't detect, or just let them be listed as less than detectable in water and obviously detectable in sediment and clams or fish or whatever.

G. Packman: There are a lot of people who would agree with you that if you're monitoring extremely low levels in a transient medium that you start to wonder what's the point, and I think we'll have to look at how far are we going to go with that, and is there another approach; do we use sediment, or do we use composite samples such as C-Star can provide. We're going to have to start getting innovative, I think, and look at what we're doing and why and maybe changing it.

B. Olding: It's sort of humorous in a way, and on the other hand, it is a problem that has to be addressed by the Water Board principally as far as the Northwest Territories go, probably the Yukon as well. What are the water uses, and then are there going to be water quality guidelines for uses established, what are we going to be monitoring for? Is it the aquatic environment or protection of fish or whatever? And that is something that's missing right now. I think there's been a statement and as I think back a number of people have told me there is no framework for decision-making and designing monitoring programs, and some of that may actually go back to the fact that we have never had the political statement made that this river body is to be used for this purpose.

The only people using it are the miners; that statement isn't quite correct, that's not at all correct, in fact, that's quite wrong. I could go further! Often at some of these mines, particularly the tundra mines, they are for much of the time out there the only people physically located on the site. However, the Canadian public has a strong sentiment for environment and I think they probably have a latently strong sentiment for the northern environment as well too, and it's a responsibility, until those objectives are set, to operate in an environmentally responsible manner.

G. Packman: I know, I know. The point is though, that the only direction that's being given to mines is make money, but keep the water clean. That's the only policy direction that we've been given, and it wavers back and forth with every decision that's made, and it's pretty tough to design programs to allow people to make decisions with that kind of direction.

P. Johnson: I think it was with respect to the background ambient monitoring programs that you were talking about people having difficulty drawing conclusions from the data. It seems to me that the purpose of those data is not to draw conclusions from them, but to ask questions from them. I think you're missing a fundamental middle stage there. That's the basis for the questions we want to answer; the conclusions come much further down the line.

G. Packman: Well, I'm not disagreeing with you, but surely if you've spent a quarter million dollars collecting data to support a decision, you should be able to make a decision on the basis of those data, and that means drawing conclusions. Maybe we're arguing semantics but, it seems to me, that if you collect data before the project goes in and you set some licence limits and you collect data after the fact and you come up to the next hearing, we should be sitting there saying, okay, we agree on the data; we may disagree on the interpretation, or how the data should be used, but we agree on the data, and that's, I think, fundamental.

P. Johnson: Yes, but if you don't know why changes might have occurred in the data from before to after, that somehow your regulatory process is wrong, then somebody's going to have to look at the reasons for those changes. So the changes that you're seeing from the before to the after, you have to investigate to find out what the cause is. Presumably, then you might be able to advance your control procedures, change your licencing requirements and so on, on the basis of that research.

G. Packman: Yes, I think it's fundamental that you're monitoring the input as well as the effects on the receiving environment, and hopefully control, so that you can draw those conclusions.

P. Whitfield: My remarks are probably more of comment than questions. First, the resource is owned by the people of Canada, and it's in our interest to protect that resource, and I think the main discussions today have been about the problems of scale. Using the resource does not mean you own it, particularly with water. And my other comment is actually a question. I think you said that the setting of objectives, or the monitoring for compliance, could be easily done, and I would take exception to that because it cannot always be done. One of the fundamental problems is cost, which may restrict it, and the fundamental problem that most agencies will have is political, to decide what those objectives are going to be. I use as a case in point the placer mining industry in the Yukon, which has been arguing about what the number will be since the day I

started 13 years ago. I know the argument was going on before then, and they still have yet to come up with the number they're going to use as compliance.

G. Packman: We were heavily weighted with N.W.T. Yellowknife people and what we're referring to there is monitoring end-of-pipe for set licence limits, and not monitoring with relation to compliance with a water quality objective or water quality guideline. I think we would put that into the category of monitoring in the ambient environment.

Yes, your point is well taken, we work for Environment Canada and that's our job to protect it, but I think we need to clarify what that means. Does that mean the CCREM water quality objectives that I put up this morning with the associated detection limits, or does it mean drinking water standards, or does it mean no fish dying in the immediate vicinity? What does it mean? I agree with you, we have a responsibility to protect the environment for Canada, that's very important. But it doesn't hold much water when you're trying to set licence limits and establish what level of change you want to detect and where. It becomes pretty difficult.

P. Whitfield: It is the department's position that that is what our business is, to protect the interests of the people of Canada with regards to water resources. That's all. I mean, we start talking about the people using it, the ownership is different than the users, and that's the point I wanted to make.

G. Packman: I agree with you, but if you take Contwoyto Lake and do you protect the stream where the decant is? Do you say that you're going to protect the fish in the shallow bay the decant flowed into? Are you going to protect the fish in the outer bay? Are you going to protect the fish in the lake? You can't have development, you can't have a decant and protect the fish in the decant stream. And that's where we have the problem. That's where it's difficult to design the programs to measure change because you don't know which fish you're trying to protect, and it's easy for the mining company or the consultant to say, well look, no one's fishing these fish. They're not fishing the fish in the effluent stream, or they never did fish there, and they're not fishing in the inner bay, and so what do you do? There's no one flying in from Winnipeg or Edmonton to fish those fish nor the people of Coppermine, so what do you do? I agree with you, we have to protect the environment, but we've got to translate that into a little more pragmatic terms.

End of Session 4

Session 5
Hydrocarbons

Session Chairperson: Mr. Brian Olding

Determination of Hydrocarbon Exposure Effects on Freshwater Northern Fishes Using Bile Analysis

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The Norman Wells oilfield underlies the river bed of the Mackenzie River at Norman Wells, N.W.T., and has a number of natural oil seeps. Limited hydrocarbon inputs also occur from the ongoing discharge of effluent from the Esso Resources Canada Ltd. refinery located at Norman Wells.

Fish are known to readily incorporate petroleum hydrocarbons into their tissues after exposure to contaminated water, sediment or food, and anecdotal reports of abnormalities in fish such as dark livers and watery flesh had been reported in the subsistence fishery 200 km downstream from the oilfield at Fort Good Hope. This paper reports the first controlled *in situ* exposures of fish to hydrocarbons with estimates of polynuclear aromatic hydrocarbon (PAH) metabolite accumulation in fish bile as well as preliminary evidence of hydrocarbon effects on fish livers.

Problems of fish flesh quality can result from extremely small concentrations of specific contaminants not discernible by many analytical techniques. Hence it was not certain that conventional chemical analysis (e.g., water, sediment, or fish) would detect hydrocarbons at a level which produced effects on fish flesh quality. An investigation was conducted to determine possible relationships between PAH metabolites in fish bile (resulting from exposure to hydrocarbons) and poor fish flesh quality. Six monitoring stations were established upstream and downstream from three sites: two natural oil seeps and the refinery effluent. Caged fish (arctic greyling and burbot) were exposed for ten days and then analyzed for PAH metabolites in bile. The results showed a trend of elevated levels of PAH metabolites downstream from both natural oil seeps and the refinery effluent. This trend was not apparent from an analysis of hydrocarbon concentrations in water or sediment or by analysis of volatile aromatic compounds in fish muscle tissue. Visual examination of fish livers by members of the community of Fort Good Hope showed a corroborating trend of unacceptable livers downstream from these sites.

Fish bile analysis for PAH metabolites provides a sensitive biochemical indicator of hydrocarbon contamination in freshwater fish. Results of this study indicated a relationship between unacceptable burbot livers, refinery effluents, and oil seeps.

Contaminant Studies with Fish from the Lower Mackenzie Drainage

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As a result of complaints from the Dene nation regarding the quality of fish in communities along the lower Mackenzie River, an investigation of chemical contamination of the fish was undertaken. The complaints specifically referred to small, dark livers in loche (burbot, *Lota lota*) and "watery" dorsal muscle in whitefish (*Coregonus clupeaformis* and *Coregonus nasus*), and people who have traditionally used these fish for domestic consumption now refuse to eat them. Since the condition of the fish was reported to have begun to deteriorate at about the same time as expansion of oil production facilities at Norman Wells, the hypothesis was suggested that the fish condition was related to contaminants released from Norman Wells. Samples of burbot taken at several communities during the period 1984-1986 revealed that the liver condition was widespread, and that both normal and abnormal livers generally appeared in the same collection. The problem was as prevalent in burbot from a small lake near Fort Franklin as it was in burbot from Fort Good Hope or Arctic Red River, indicating that Norman Wells was not an exclusive cause. An earlier study of burbot from the Tanana River, Alaska, suggested that a similar condition existed in some of the burbot there in the mid-1960s. Liver mixed-function oxidase enzymes suggested that the burbot were not in a state of biochemical response to oil, but that they may have been responding to a phenobarbital-type of inducer. The water content of whitefish from the lower Mackenzie River was higher than that reported for whitefish from most sources farther south. Analyses of fish for contaminants revealed some low-boiling mono-aromatic compounds typical of petroleum, with samples from late winter having much higher levels than samples from late summer, suggesting a source under the ice. Several polyaromatic hydrocarbons were also identified. Metals were within ranges established from previous reports from other Canadian fisheries. Several organochlorines were found, most notably toxaphene, chlordane, PCBs, chlorobenzenes, HCH, DDT, and dieldrin. The implications of these results for water quality monitoring are discussed.

B. Olding:
Chairperson
Work Group 1

In our group what we did is we focused initially on the northern Mackenzie River basin and on the hydrocarbon monitoring that has been done to date. We started getting a bit broader from there and that seemed to work out fairly well. The main question we asked ourselves is, what has taken place to date? We made a list of some of the key work done by the people in the room, we identified the concerns as best we could, and then we went around and said, okay what do we know? What are the main conclusions we can state right now? Is there anything? Is this a significant question, is there anything here that we should be concerned about? Are we wasting money or what, or should we continue? I'll just quickly run through each one of those.

There are two pieces of delta work going on here. One is in the Mackenzie delta. The Sediment Survey has been carrying out work on sediment transport through the delta, and that will undoubtedly relate to some of the work that we're doing in terms of sediment movement and river transport. Secondly, Alberta Environment is now planning an Athabasca delta study and one of the things on which they are focussing is fish tainting. That's in the design stage right now and they'll be consulting us about that work as we consult them about our work. With EPS and their consultants EVS, for the first year they did two things. One, they chemically characterized the natural seepage in the river as well as the effluent from Norman Wells, and differentiated the two. Fish exposure to hydrocarbons as determined by bioanalysis was considered a successful tool.

NWRI in years past, with Rod Allan, had carried out work in ponds on oil spills and the degradation of the oil in those ponds. That work has stopped now, there are some background data there. NWRI in conjunction with the Water Quality Branch, we've done two surveys down the river on water and sediment, and we've picked up n-alkanes and PAHs. Those are definitely there. Organochlorines, done by DFO. We know that those are definitely there. So there are a number of things we can definitely say right now. Pacific and Yukon Region is carrying out work on the Peace River on hydrocarbon analysis. We're not sure exactly to what extent that takes place. So those are the activities that are taking place. There's what's done; what can we say.

What we say is that there are hydrocarbons in the fish, petroleum hydrocarbons specifically. There is no question about that. The fact that there are complaints on the river, there's no question about that, and the analysis based on those complaints that

has been carried out indicates that they correspond with the increasing concentrations of contaminants from above Norman Wells down to Fort Good Hope. We know there are organochlorines in the fish. No question about that; they're there. We also know that bile is a good indicator. So there's the state of the knowledge bank right now.

Things that we don't know. We don't know enough about fish movements, fish behaviour in the system, migratory behaviour, rearing, spawning, uptake. We don't know enough about sources and particularly this thing that's coming out with LRTAP. We can't differentiate right now between LRTAP, between Liard River basin inputs, the seeps and Esso. Pathways, we're just scratching the surface and really don't know very much about how these hydrocarbons are moving through the system, either through the air vectors or through the water and sediment.

Control. If we turn out to have a significant LRTAP consideration here, that's something that is going to be out of our hands naturally. There will be a need for a well-documented database, if there are going to be international negotiations or interjurisdictional negotiations at whatever level regarding that. Reflux, referring to what's going into the system, what's its fate? Where does it drop out? Does it come out? We hardly know anything about that at all.

The next question we asked ourselves is this. How we should spend taxpayers' money? Should we be putting efforts elsewhere? And we went around the room and there was a very firm statement of yes, we should continue, and there were a number of reasons given for that. From building up a database for interjurisdictional negotiations, to the responsibility of Environment Canada to determine pathways. So once that was established, the point was made that we need a hook. Who's interested, and particularly decision makers and money givers. The need to co-operate has been brought out in all of these things, I guess it's a bit of a motherhood statement and it keeps being made over and over again.

These are kind of a random order, things that should be considered while we're doing the monitoring. The plants and animals, the work on peat bogs, lichens have been indicated as possible, the work on acid rain, the uptake for riverine mammals might be a good indicator, lichen sampling. As far as water went, cores on lakes and the pathways moving through the system, sediment and water, continue that work, needs to go on. Transboundary is emerging as a more important issue,

particularly with the Alberta bilateral negotiations, and they will probably broaden out eventually into the B.C. negotiations, so we'll need data on the Liard as well as on the Slave River. We don't have any right now at all. LRTAP kept emerging over and over again, every time we talked. There's no question at all, I think in our group, that LRTAP was a major phenomenon that we need to address. If it is going to be addressed, the suggestions were made that wherever a LRTAP station was established, that you establish a contaminant sink with it which may be fish, for example, may be lichen; we'll have to decide on some appropriate measure for that, so that we're monitoring what's taking it up.

There was some dissension in terms of, do you do one study really well or do you try and get a very broad coverage of things? So that was about that. That's about it really. I think the net conclusion was that there was a strong consensus that we go and continue with our work. That's it.

L. Johnston:
Chairperson
Work Group 2

As soon as we all sat down and started to talk we realized that none of us were experts in hydrocarbons. Also we knew that the group beside us was talking specifically about the Mackenzie Basin. Therefore, in about the first ten or fifteen minutes of discussion, we came to two conclusions. One was that we wouldn't talk about the Mackenzie Basin, and the second was that we would talk about the broader range of materials beyond hydrocarbons and our discussion tended to follow the latter part of your group's discussion which was to the LRTAP and the long-range transport of toxic chemicals. Not necessarily acid rain, not necessarily pesticides, but long-range transport in general.

We did come down to the agreement that there were two specific types of problems in the North. One was site specific, for example mining, hydrocarbons, pesticides from agriculture. The second type was the non-point source, the long-term, such as LRTAP, climate change.

We had a fair amount of discussion on the next three items, the problem identification, what the effects were, what were the causes and the sources. We had similar problems to those of the previous group in determining which direction a monitoring program should take. We decided that for the site specific problems it was a relatively easy process, relatively easy - and I stress that - to see the effect, such as the liver problem we heard about this morning, or high levels of organics in seals, high levels of chemicals.

That was a relatively easy thing to see, especially if there was a point source available. The causes, once

you saw an effect, there was a certain amount of problem determining what the cause of that effect was, and this took us off in several discussions. The third one, which is almost a subset of the second one, was looking at the source of these effects. Where we got into a fairly interesting discussion, was looking at the long term non-point source types of pollution, and trying to determine the effect of this pollution. We are in agreement with the other group in that the cause coming from the long range is extremely difficult to deal with, as is the source.

We came to several conclusions. The problem of resolution. We talked about the technical aspects of how, once you'd identified the problem, how you would go about dealing with site specific pollution, or non-point source pollution. The site specific again was relatively straightforward in that there was a potential source. The effects were usually reasonably well known, and a program could be designed to look into the problem.

When we got into the non-point source, it became extremely difficult because again there, it's the hook that you mentioned earlier, that if it's out in the middle of nowhere, why study it, and we went round on that one as people have for the last several days, and decided that while we could come up with a technical game plan such as looking at the available literature, doing snow sampling studies, doing water quality studies, in the long term for non-point source it was really almost a political question, or, more importantly, a political question than a technical one. From this first part of the discussion there were several conclusions, but I'd like to amalgamate them with the conclusions and the recommendations from the second part of the discussion this morning, which was looking at the workshop and the results of the last three days in general, and if we're being presumptuous. We felt that it was worthwhile reflecting on the three days that we've been here and trying to arrive at some recommendations, conclusions from the overall aspects as well as the discussion that we had this morning.

The first one was that there had to be better co-ordination of the numerous agencies involved. This applied both to the federal agencies involved in the studies, and to all agencies, whether it is mining, university, industry, whatever agencies are involved, in these types of studies.

The second one stressed over and over again was benefitting from local expertise and observation, that

there has to be a component of the people involved, a very large component. Again the example of the fish liver this morning, identifying a problem, that was the local expertise.

Third, that there is, in some areas, a fair amount of data available or information of one sort or another, and that this should be reviewed and interpreted as a type of baseline, a background study, as to what the current state of knowledge is about the problems of northern water quality. Or the good things about northern water quality.

Fourth, and probably one of the more important ones, although we did try to order these in a general sense, was to improve the public relations, the public information, public awareness. There seems to be a perception that the North is absolutely pristine. There is this feeling that the North is without problems and therefore it's not worth spending the effort or the money to look at what is going on.

The fifth one was the fact that there need to be objectives in the North and that these need to be periodically reviewed. What may be the most important problem this year is not necessarily the most important problem five years from now, which led into the next three points: the sampling optimization, which we all were for; multi-media sampling, which while we didn't take an official vote I'd say it's reasonably unanimous; and there was also a call for more research. But leading to information on the points that came before, not research for the sake of research, but tied in to the needs that are identified before.

Then at the very end we had two general comments on this workshop process itself. One was that it had been a very useful three days. There was a need for ongoing workshop series on northern water quality issues, and we chose issues rather than problems or any other word for the reason that it's the whole issue of water quality, and then finally that in future, if there are future, workshops the working groups should be more focused than they were this time. Accepting that this was an initial try to look at the general lay of the land, but in future, hopefully, taking this first step that groups would be more focused and that could lead to choosing chairmen, chairpeople ahead of time, having position papers prepared, and just generally zeroing in on the problems, the issues that have been identified in this workshop.

End of Session 5

R. Kwiatkowski: A number of people have asked me where do we go from here? Basically, we had anticipated two proceedings being produced out of this workshop. One would be a rather general and would report in verbatim format day 1, and include abstracts of the scientific papers given in the other sessions, and the general discussions that we have had after each work group.

The other proceedings will come out as a special issue of the Water Pollution Research Journal of Canada. Those are the presentations in sessions 3 to 5. All the authors have received their instructions. I believe it was June 1 that they have to have their draft in to me. These will be reviewed scientifically for the journal. Reviews will be sent to the authors for corrections. We will have this special issue published some time in December, January.

One of the main objectives that I saw for this Workshop was the identification of a need for more work groups, workshops, what have you. Laura mentioned the fact that they should be more focused and I agree wholeheartedly. The difficulty with the first one is that you have to set some sort of priority as to which ones you should look at first, whether it's a workshop on research needs; a workshop on ground water; a workshop on the setting of guidelines, objectives. It is sometimes difficult to set out a nice logical priority.

However, we did clearly identify the fact that workshops are needed, and I guess the individuals who want to pursue that will now have to justify why they should be first. I guess at that point I'll just leave it at that. Thank you very much for your participation and I'd like to add that it was great having you here.

Water Quality Issues in the Territories: Recommendations and Conclusions

by
R.E. Kwiatkowski

Water Quality Issues

As the North continues industrial expansion, there is an increased demand for water use in resource processing and other industrial uses, and for use by an expanding population. Eight major water quality issues requiring monitoring activities in the Territories were identified in the Workshop.

1. Mining: Potential minerals awaiting discovery and eventual extraction from the North are truly impressive. 1 840 000 square kilometres of Precambrian rock and 260 000 square kilometres of Paleozoic rock favourable for minerals exist in N.W.T., while over 520 000 square kilometres of proven mineral districts exists in the Yukon (DIAND 1974).

2. Oil and Gas: Approximately 1 160 000 square kilometres of the North is underlain by sedimentary rocks that may be considered to be potentially productive for oil and gas (DIAND 1974).

3. Municipalities: There are approximately 72 municipalities in the North. All communities have treated water supply delivered by truck or pipe in the Yukon. In the N.W.T., only approximately 1% of drinking water comes from ground water. However, in the Yukon, half of the drinking water is obtained from ground-water sources. Most communities have some form of sewage treatment, varying from primary treatment, to seasonal discharge of secondary sewage treated in lagoons. Some small communities require no treatment because discharge is by way of privies.

4. Transboundary Water: Significant amounts of water in the Yukon and Western N.W.T. originate from outside the territories. Transboundary monitoring of this water to ensure that the Territorial present and future uses of the water are protected is of major concern as development (water diversions, tar sands, oil and gas exploration etc.) outside the territories continues.

5. Long Range Transport of Airborne Pollutants: Eastern N.W.T. may be particularly vulnerable to acid rain. Toxic contaminants are drifting into the North, not only from the south but also from over the Pole, from Eurasia.

6. Hydroelectric: Although presently no hydroelectric development is occurring in the North, the hydro-generating capacity of the Territorial rivers is considerable. Since the mid-1950s a number of surveys have been conducted and a quantitative assessment of the undeveloped hydro power resources in the North stands at 10 000 000 kilowatts (DIAND 1974).

7. Ground water: Because of the increased costs of doing ground-water monitoring versus surface water monitoring, little information on ground- water issues in the North presently exists. However, the potential for contamination by mining, and oil and gas development exists.

8. Crisis Monitoring. There are approximately 200 accidental chemical spills each year in the North, ranging from petroleum products to oxidants used in extraction of the base metals. The resources (manpower) to respond to these incidentals can often only be obtained from the temporary reduction in the long-term routine monitoring efforts, resulting in data gaps in these valuable data gathering exercises.

With the limited resources available for monitoring in the Territories, the importance of careful planning was identified by workshop attendees as paramount (Fig. 1). Once an issue is identified, efforts to obtain all available information on any issue must be made to reduce duplication of effort and the potential loss of acquiring valuable new insight. Sources of information include previous studies, other government agencies, universities, local citizens and consulting firms. The information gathered during this phase of the project supplies the initial answers to: What are the present and potential problems/issues within the river basin? Where are the point sources located? When in the hydrological cycle is the problem/issue most acute? Is there a need for a pilot/special study to provide information for the establishment of realistic monitoring objectives? Without this basic ecological information, no scientific way to establish station location, sample parameter lists or sample frequency exists, resulting in poor network design and limited information acquisition (even though a large amount of data may be obtained). Gaps in knowledge must be identified and assistance from the research community requested. If no information gaps exist, and problems/issues are clearly identified, routine monitoring for the identification and determination of levels, concentrations, trends and natural variations of chemical compounds in water, sediments and biota, can be carried out.

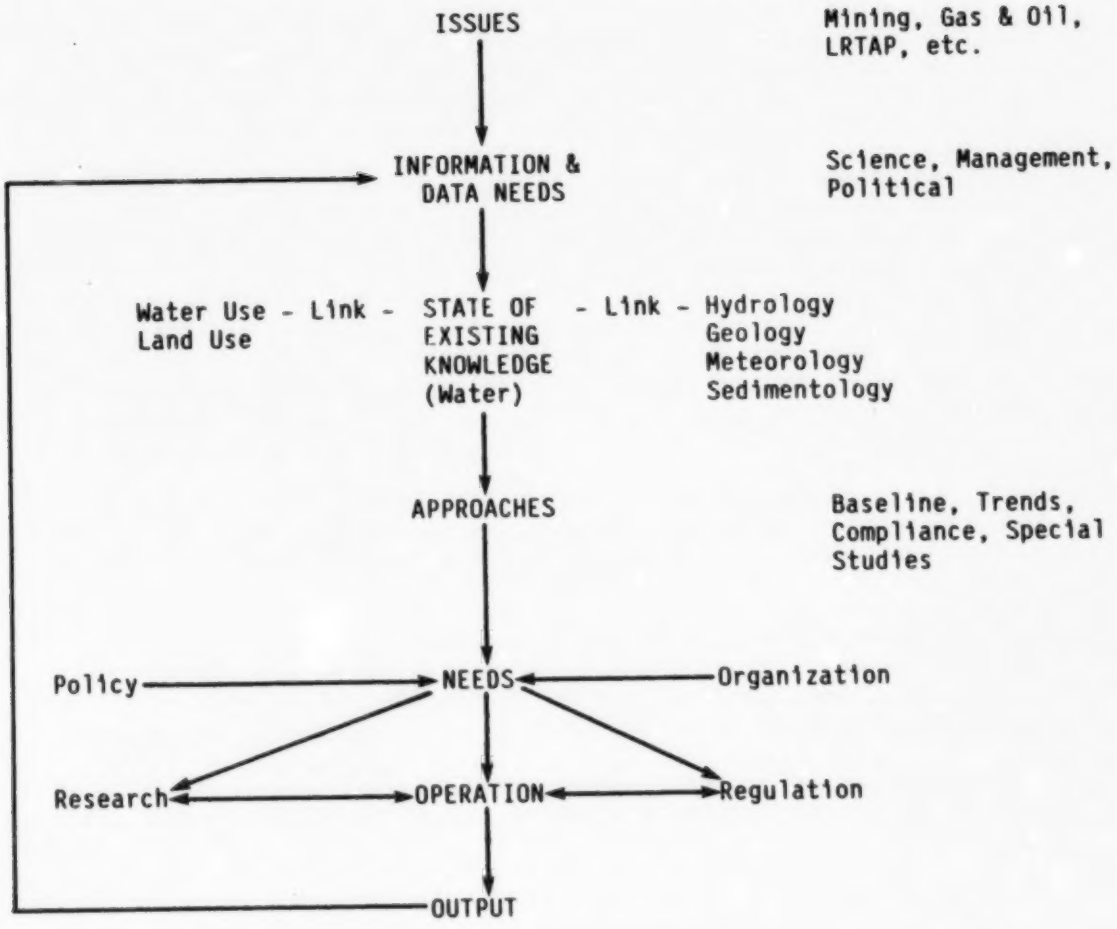
Recommendations

Specific recommendations on monitoring of the northern aquatic environment were made during the four-day workshop. Recommendations were made on three major themes - General Monitoring, Mining and Hydrocarbons.

General Monitoring

1. The concept of one monitoring network type providing satisfactory information for all data users is obsolete. Network types (baseline, trends, compliance, etc.) must be clearly identified. The ultimate objective of monitoring activities is to supply the scientific information and advice that will prevent deleterious impacts on the environment of man's activities.

Figure 1: Flow Chart to Monitoring Activities



ii. The multimedia approach: biotic integrators, sediment (suspended and bottom) and large-volume (>20 litres) water samples should be used. Information on levels, trends, partitioning tendencies, transport, accumulation patterns and ultimate fate of deleterious substances is required before the "health" of the aquatic ecosystem can be assessed.

iii. A Quality Assurance Management Plan for the Territories should be developed to ensure that all participants in water quality monitoring activities (government and non-government) fully understand the required level of competence in the final data.

iv. Quality Assurance/Quality Control (QA/QC) protocols for the Territories should be established, agreed to, and documented for both field and laboratory operations. There is a need for an external audit function on laboratory QA/QC and for laboratory certification or accreditation. Interlaboratory round-robin participation must be encouraged in the North.

v. More effort into Gas Chromatograph/Molecular Spectroscopy (GC/MS) scans of multimedia (water, sediment and biota) samples should be carried out to determine whether toxic substances, other than those on a standard "menu driven" parameter list, are present.

vi. Researchers and monitoring agencies must bring their findings to the attention of regulatory decision makers (e.g. the Territorial Water Boards) in a timely fashion. Industries requiring a water licence do not have the luxury of time. Deadlines must be met, flow-through money must be spent in the fiscal year, and shareholders want a timely return on their investment. Research results all too often appear in the scientific literature well after a regulatory decision has been made, and the regulatory agency may or may not even be aware of the information.

Mining

i. Water quality objectives aimed to protect the local environment (water uses) should be prepared for the mining industry. Once the objectives are established, field and laboratory protocols will be needed to ensure consistency with: station location (how far downstream from the end of the pipe should the sampling station be and how large is the mixing zone?); sample collection, preservation, handing and analysis; calibration procedures;and data reduction and statistical analysis.

ii. Tax incentives for mineral exploration should be expanded to include incentives for baseline environmental characterization by the mining industry.

iii. Governments should levy an extra tax, based on a per tonne basis, on the mining industry in the North. The funds generated would be used solely for the purpose of research and impact assessment of mining activities in the Territories.

iv. Mines should be asked to provide a performance bond prior to the development stage. The bond issue should be large enough to pay for environmental cleanup if the mine goes bankrupt and the mine site is abandoned.

v. A holistic/ecosystem approach to monitoring mine impact is needed. Simple end-of-pipe monitoring for compliance is inadequate to ensure protection of the aquatic research. Sources, pathways, fate and effects must all be monitored. Too much effort on concentration in a given media versus loadings to the environment presently exists in mine monitoring activities.

vi. Due to the limited knowledge base on basic limnology of northern river/lake basins, monitoring of affected and unaffected basins was recommended to assist in the interpretation of long-term effluent versus episodic or periodic spill effects, from natural seasonal variation or long-term natural cycling.

vii. A better mechanism (possibly the Territorial Water Boards or the Environmental Advisory Committees) for coordination of monitoring activities (network design, QA/QC, field and laboratory protocols etc.) by the government agencies and mining community is needed.

Hydrocarbons

i. Research on the physical, chemical and biological characteristics of hydrocarbons in the North is needed. For example: information on the seasonal rate of photochemical and biological degradation (particularly under ice or snow), oil slick spreading rates, evaporation rates and direct toxicity.

ii. Research on the fisheries resource of the Territories is needed. For example: information on growth rates, spawning behaviour, migratory routes, and uptake and depuration rates for hydrocarbons.

iii. Research on the transport mechanisms for volatile hydrocarbons in the northern environment, such as the influence of Long Range Transport of Airborne Pollutants (LRTAP) is needed.

iv. A complete survey of the Territories for the identification of present or potential sources of natural oil and gas seepages should be carried out.

v. Research on safe mechanisms for the storage, transport and cleanup of hydrocarbon products is needed. Early detection methods (surveillance) for spills in remote areas, to facilitate timely remedial action, are required.

Conclusions

Fostering public participation in federal environmental activities conforms to the Department of the Environment's policy of federal cooperativeness and with the concept of a shared responsibility for the environment. The public at large and the scientific community have been awakened to the necessity of protecting Canada's North, both for the sake of long-term economic prosperity and for the overall quality of life for all Canadians. Much of the public's present concern with the environment is focused on water. Any degradation of its quality requires immediate action by government agencies (Pearse *et al*. 1985). In the present climate of expenditure restraint, both the Yukon and the Northwest Territories, representing one third of Canada's land mass, are particularly hard hit.

The North has been blessed/plagued with large areas of potentially valuable minerals and oil, a small population, and until recently, has been perceived as a pristine environment. As a result, little background

environmental data exist, and the potential for substantial new resources to become available for environmental work is low. However, the potential for future development and therefore future degradation of the environment is high. Relations with other federal agencies, provincial/territorial agencies, environmental groups and the general public have always been a high priority activity by Environment Canada. The Northern Water Quality Monitoring Workshop, although dominated by government personnel (a reflection of the costly monitoring activities in the Territories), broke away from the traditional approach of experts conversing with experts on a given water quality issue. The concept of the May 4-7 meeting was more functional than traditional. Industry (mining, oil and gas), government, scientific, and lay public were encouraged to present their views on the areas of strength and weakness in existing knowledge, and on the needs and priorities of water quality issues in the North. Work group sessions were deliberately mixed to ensure representation of all aspects of the environmental issue.

Participants strongly felt that northern water resource managers should not become complacent by the deferral of megaprojects, such as the Liard River Dam or development of numerous hydrocarbon or mining activities, due to volatile international commodity markets. The need for water quality data for the purposes of: identifying baseline conditions, establishing long-term trends, negotiating site-specific water quality objectives, identifying emerging water quality issues, and assessing the effectiveness of regulatory or remedial measures was clearly identified. One definitive recommendation on the future of water quality assessment in the North was that much will depend on working together constructively, establishing links among the organizations responsible for monitoring, and being able to develop an assessment framework from which all can work. As observed by one participant, all that is needed to improve our knowledge base on water quality in the North is good planning, good execution and obviously - a lot more money! The Northern Water Quality Monitoring Workshop focused on the first two of the above three requirements. The measured effect in increased co-ordination, planning and implementation of activities by the agencies responsible for water quality monitoring in the North will only be seen in future years. However, work group participants did produce concrete recommendations to improve monitoring activities in the North for three sectors: General monitoring, Mining, and Oil and Gas. The Workshop was a learning experience for all participants, in particular for those individuals not privy to the scientific conferences and workshops so often held in the southern parts of Canada. The Workshop led to a sharing of ideas and to a better understanding of the positions and views held by the water managers, the researchers, the operational components and the native northerners. Communication, an intangible output, often produces the most tangible result - better, more cost efficient, monitoring activities.

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